Use of Intensive Care Units for Patients With Low Severity of Illness

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**Objective:** To determine variations among hospitals in use of intensive care units (ICUs) for patients with low severity of illness.

**Design:** Retrospective cohort study.

**Setting:** Twenty-eight hospitals with 44 ICUs in a large metropolitan region.

**Patients:** Consecutive eligible patients (N = 104,487) admitted to medical, surgical, neurological, or mixed medical-surgical ICUs from March 1, 1991, to March 31, 1995.

**Outcome Measures:** The predicted risk of inhospital death for each patient was assessed using a validated method that is based on age, ICU admission source, diagnosis, severe comorbid conditions, and abnormalities in 17 physiologic variables. Admissions were classified as low severity if the patient’s predicted risk of death was less than 1%. In a subset of 12,929 consecutive patients, use of 19 specific interventions typically delivered in ICUs was examined.

**Results:** Twenty thousand four hundred fifty-one admissions (19.6%) were categorized as low severity, including 23.6% of postoperative and 16.9% of nonoperative admissions. Alcohol and other drug overdoses accounted for 40.2% of nonoperative low-severity admissions, laminectomy and carotid endarterectomy accounted for 52.3% of postoperative low-severity admissions. Mortality among patients with low-severity illness was 0.3%, and only 28.6% received an ICU-specific intervention during the first ICU day. Although mean ICU length of stay was shorter (P<.001) in low-severity admissions (2.2 vs 4.7 days in nonoperative and 2.4 vs 4.2 days in postoperative admissions), low-severity admissions accounted for 11.1% of total ICU bed days. Rates of low-severity admissions varied (P<.001) across hospitals, ranging from 5% to 27% for nonoperative and 9% to 68% for postoperative admissions.

**Conclusions:** A large proportion of patients admitted to the ICU have a low probability of death and do not receive ICU-specific interventions. Rates of low-severity admissions varied among hospitals. The development and implementation of protocols to target ICU care to patients most likely to benefit may decrease the number of low-severity ICU admissions and improve the cost-effectiveness of ICU care.

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PATIENTS AND METHODS

HOSPITALS

We conducted this study in 38 ICUs in 28 hospitals in northeast Ohio. All hospitals were participants in Cleveland Health Quality Choice, a regional program to examine hospital performance. Nineteen of these ICUs were medical-surgical; 8 were medical; 8 were surgical; and 3 were neurological and/or neurosurgical. Thirteen additional ICUs that specialized in coronary care (n=11) or cardiovascular surgery (n=2) were excluded from the study, per Cleveland Health Quality Choice protocols. Eight of the 28 hospitals had more than 1 ICU included in the analysis. The mean number of beds (excluding "stepdown" beds) of study ICUs was 16 (range, 4-42). Five hospitals that were members of the Council of Teaching Hospitals of the Association of American Medical Colleges were classified as major teaching hospitals, and 6 additional hospitals with 1 or more allopathic (n=4) or osteopathic (n=2) residency training programs were classified as minor teaching hospitals.

PATIENTS

The eligible sample included 136,491 consecutive patients ages 16 years or older admitted to study ICUs from March 1, 1991, to March 31, 1993. The following patients were ineligible for the study: (1) patients with burn injuries, because they were preferentially admitted to a single hospital; (2) patients admitted to the ICU solely for hemodialysis, because many hospitals had dedicated dialysis units and would not admit such patients to ICUs; (3) patients boarded in the ICU for less than 4 hours following a surgical procedure; and (4) patients who died within the first hour after ICU admission or within the first 4 hours after admission to the ICU in cardiopulmonary arrest, because outcomes in such patients may be less attributable to quality of care. Of the eligible sample, 24,072 patients with diagnoses that would be managed in coronary care or cardiovascular surgery units (acute myocardial infarction or chest pain, n=10,468; unstable angina, n=7,468; cardiac arrhythmias, n=4047; and coronary artery bypass, cardiac valve, or heart transplant surgery, n=2089) were excluded from analysis because admissions to such units were ineligible. These patients may also be admitted to ICUs for cardiac monitoring, independent of acute physiologic abnormalities. In addition, 7316 patients who were readmitted to an ICU during a single episode of hospitalization and 616 patients (0.5% of eligible sample) with missing severity of illness or admission diagnosis information were also excluded, resulting in a final study sample of 104,487.

RESULTS

The mean age of the 104,487 study patients was 61.9±18.1 years, and 52.0% were male. Of the study patients, 42.1% of patients were admitted to the ICU from the operating room or recovery room; 37.1%, from the emergency department; and 11.7%, from another hospital ward. The remaining patients were admitted from another ICU or another acute care hospital or were direct admissions. The mean APACHE III Acute Physiology Score was 48.6±28.2, and the mean hospital and ICU stays were 12.6±13.2 and 4.1±5.2 days, respectively. Observed mortality was 11.8%. Of the 12,360 patients who died, 55.4% died in the ICU during initial ICU admissions.

Among nonoperative admissions (n=62,771), the 10 most common ICU admission diagnoses included congestive heart failure (13.0%), alcohol and other drug overdoses (7.5%), hemorrhagic peptic ulcer disease (6.3%), nonhemorrhagic stroke (4.7%), bacterial or viral pneumonia (4.4%), chronic obstructive lung disease (4.4%), head trauma (4.0%), nonunary tract sepsis (3.8%), seizure (3.0%), and postcardiac arrest (2.7%). Among postoperative admissions (n=41,716), the 10 most common diagnoses included carotid endarterectomy (11.9%), peripheral vascular disease with bypass (9.5%), vertebral laminectomy (7.7%), gastrointestinal tract neoplasm without obstruction or perforation (6.8%), peripheral vascular disease without bypass (6.1%), lung neoplasm (5.2%), gastrointestinal tract obstruction (4.8%), craniotomy for neoplasm (4.0%), multiple-site trauma excluding head (3.9%), and elective abdominal aneurysm repair (3.8%).
patients are often admitted to ICUs. The 3 general types of interventions consisted of mechanical ventilation or tracheal intubation, invasive monitoring or treatment procedures (ie, intra-arterial or pulmonary artery pressure monitoring, cardiac pacing, electrical cardioversion, left-ventricular assist devices, pericardiocentesis, urgent hemodialysis, tamponade of gastric or esophageal varices, and ventriculostomy), and pharmacologic and other therapies (ie, arterial drug infusion; intravenous infusion of vasoactive drugs, antiarrhythmic and thrombolytic agents, anticonvulsants, or mannitol hexanitrate; rapid blood transfusions or intravenous fluid replacement; barbiturate anesthesia; and intravenous treatment of acid-base abnormalities).

SEVERITY OF ILLNESS

Measurement of admission severity of illness was based on the Acute Physiology and Chronic Health Evaluation (APACHE) III method. For each patient, an APACHE III Acute Physiology Score was determined on the basis of age, presence of 7 severe comorbid conditions (acquired immunodeficiency syndrome, hematologic malignant neoplasms, metastatic cancer, use of immunosuppressive agents, hepatic failure, lymphoma, and cirrhosis), and abnormalities in the 17 physiologic variables. Scores have a possible range of 0 to 299 and were determined using previously validated weights for each variable.

A predicted risk of in-hospital death was then determined using a multivariable logistic regression model that included the APACHE III Acute Physiology Score, ICU admission source (expressed as 7 indicator variables), and ICU admission diagnosis (expressed as 75 indicator variables). To improve model fit (ie, calibration), APACHE III Acute Physiology Scores were represented in the model as a continuous variable and as 2 additional indicator variables for scores that were less than 20 or greater than 150. Other representations of this score (ie, logarithmic or exponential transformation) were tested but did not improve model discrimination or calibration. Discrimination of the final logistic regression model, as assessed by a receiver operating characteristic curve area of 0.901, was nearly identical to the discrimination initially reported for the APACHE III method.

The mean predicted risk of in-hospital death in all patients was 11.9% and was nearly identical to the observed rate of death. Distributions of predicted risks of death for nonoperative and postoperative admissions are shown in Figure 1. Patients with low-severity illness accounted for 19.6% of all admissions, including 23.6% of postoperative and 16.9% of nonoperative admissions. Rates of low-severity admissions declined somewhat during the 4 years in which data were collected (21.2%, 19.6%, 18.9%, and 18.8% in years 1 to 4, respectively; \( P < .001 \)).

The mean predicted risk of death among low-severity admissions was 0.5% and was somewhat higher than the actual death rate of 0.3% \( (P < .001 \ [\chi^2]; 1 \text{ df}) \). Of the 62 patients with low severity of illness who died, only 13 (ie, 0.06% of all low-severity admissions) died during the first 4 days following ICU admission. Compared with other patients, patients admitted to the ICU with low severity of illness were younger and more likely to be male (Table 1). In addition, patients with low severity of illness had shorter ICU and hospital lengths of stay. Nonetheless, low-severity admissions accounted for 11.1% of total ICU bed days and 10.3% of total hospital bed days. Among nonoperative admissions, alcohol and other drug overdoes accounted for 40.2% of all low-severity admissions. Indeed, 90.0% of all overdose admissions were classified as low severity; among these patients, the mean length of ICU stay was 2.0±1.6 days, and only 9 patients (0.2%) died. The following 6 other diagnoses accounted for an additional 30.6% of nonoperative low-severity admissions: multiple-site trauma (excluding head or brain) (7.6%), diabetic ketoacidosis (6.7%), head or brain trauma (5.8%), seizures (4.4%), asthma (3.1%), and hypertension (3.0%). Among postoperative admissions, the following 2 diagnoses ac-
counted for 52.3% of low severity admissions: carotid endarterectomy (29.4%) and vertebral laminectomy (22.8%). The following 3 other diagnoses accounted for an additional 19.7% of postoperative low-severity admissions: urinary tract neoplasms (9.3%), peripheral arterial bypass (5.9%), and craniotomy for neoplasm (4.5%).

Substantial variability in rates of low-severity admission was observed across the 28 hospitals (Figure 2, top and bottom). For nonoperative admissions, rates of low-severity illness ranged from 5.2% to 27.5%; in 23 hospitals, rates were significantly (P<.001) higher or lower than the overall population rate of 16.9%. Even after excluding admissions for alcohol and other drug overdoses, hospital rates ranged from 4.9% to 16.6%, and 14 hospitals had rates significantly higher or lower than the overall rate of 10.9%. For postoperative admissions, rates ranged from 9.4% to 68.0%; in 15 hospitals, rates were significantly higher or lower than the overall rate of 23.6%. Hospital rates in nonoperative and postoperative admissions were moderately correlated (Pearson correlation coefficient, 0.43; P = .02). In addition, variability existed according to teaching status (Figure 2, top and bottom). For example, the mean rate of low-severity admissions was lower in the 5 major teaching hospitals than in the 23 non-teaching and nonteaching hospitals for nonoperative (11.0% vs 18.5%; P<.001) and postoperative (17.7% vs 24.5%; P<.001) admissions. However, mean rates were similar in the 6 minor teaching and 17 non-teaching hospitals (21.4% vs 18.3%, respectively [P=.28], for nonoperative admissions; 25.8% vs 23.9%, respectively [P=.86], for postoperative admissions).

Correlations between rates of low-severity ICU admission in individual hospitals and hospital SMRs were not significant for nonoperative (R=0.13, P=.50) or postoperative (R=0.16; P=.41) admissions. Thus, hospitals with higher proportions of low-severity admissions did not have lower SMRs.

Finally, in analyses of the 12,929 patients for whom data were available on the use of ICU-specific interventions, use was substantially lower in low-severity admissions (Table 2). Nevertheless, 28.6% of patients with low severity of illness received 1 or more ICU-specific interventions, including 45.3% of postoperative and 12.1% of nonoperative admissions. The most common intervention was intra-arterial pressure monitoring, which was used in 23.1% of patients with low severity of illness. Excluding intra-arterial pressure monitoring, only 12.1% of postoperative and 11.4% of nonoperative low-severity admissions received 1 or more other interventions.

The costs associated with intensive care represent a major component of the United States’ health care expenditures, accounting for nearly 1% of total gross domestic product.11,19 However, few previous studies have examined how hospitals use ICU beds or whether such practices vary across individual hospitals. Examining consecutive ICU admissions during 4 years to 28 hospitals in a large metropolitan region, we found that ICUs often are used for patients in whom the risk of death is exceedingly low. Nearly one fifth (19.6%) of the patients in our sample had a predicted risk of death of less than 1%, whereas 40.0% had a predicted risk of death of less than 2%. Although we did not directly measure the appropriateness of ICU admission in these patients, their low in-hospital mortality (particularly during the first 4 days of hospitalization) suggests that many patients with low severity of illness may be treated effectively in non-ICU settings.

Although analyses in a subset of the study sample indicated that 28.6% of patients with low severity of illness received 1 or more interventions that are typically delivered in ICUs, the larger proportion of such patients had low severity of illness and did not receive any active ICU interventions. Moreover, nearly 62.0% of all patients with low severity of illness who received interventions received only a single intervention (intraarterial blood pressure monitoring), for which effectiveness is poorly studied.

We further found that rates of low-severity ICU admissions exhibited substantial variability across hospitals: roughly 5-fold for nonoperative and 7-fold for postoperative admissions. Results were generally similar if different criteria for low severity were applied. For example, if admissions were classified as low severity when the patient’s predicted risk of death was less than 2%, hospital variation in low-severity admissions was nearly 4-fold for nonoperative (12%-46%) and postoperative (24%-83%) admissions.

Two operative (carotid endarterectomy and vertebral laminectomy) and 1 nonoperative (alcohol and other drug overdose) diagnosis accounted for almost half of the low-severity ICU admissions. In patients with carotid endarterectomy, close observation of postoperative blood pressure and neurological status is recommended because of the incidence of hemodynamic instability and postoperative stroke.23 However, no studies have established the effectiveness of the ICU in such patients or the optimal period of ICU observation. Following laminectomy, routine neurological monitoring in an ICU is frequently performed, although the benefit of this practice has been questioned.24 Admission to the ICU may be used...
in certain institutions to ensure more vigilant neurological observation by nursing personnel.

In patients with drug overdose, routine ICU monitoring has been recommended. However, several studies have shown that most patients with overdoses do not require ICU care and that patients at risk for complications can be identified on the basis of simple clinical findings such as electrocardiographic changes, airway compromise, ad-
mission vital signs, level of consciousness, and abnormal results of arterial blood gas studies. Although some low-severity ICU admissions may be indicated, formal assessment of the benefits of ICU care in patients with these diagnoses is needed. The results of such analyses would likely have important implications for ICU use.

Although variation in use of ICUs has been poorly studied, our findings appear consistent with those of 2 earlier studies by Knaus et al. In an analysis of ICU admissions in 1979 to 1981, mean predicted risks of death ranged from 10% to 43% across 13 tertiary hospitals; in a follow-up study a decade later of ICU admissions in 40 hospitals, the range in predicted risk of death was nearly identical. We suspect that both studies probably would have found substantial hospital variation in the proportion of low-severity admissions. Indeed, in a further analysis of data from the second study, the proportion of admissions who did not receive active ICU treatment (ie, interventions typically delivered in ICUs) varied across hospitals; such patients accounted for less than 20% of ICU admissions at 5 hospitals, 20% to 40% of admissions at 20 hospitals, and more than 40% of admissions at 15 hospitals.

Our results are also consistent with those of numerous studies demonstrating regional variations in rates of hospital admission, surgery, and physician expenditures or that a substantial proportion of hospital admissions may be inappropriate on clinical grounds. For example, the Rand Health Insurance Study found that 23% of medical and surgical admissions from 1974 to 1982 were inappropriate, and that rates of inappropriate admissions varied from 10% to 35% across the 6 US regions studied. In addition, studies of adult populations that were conducted before and after the introduction of prospective payment in 1983 found rates of inappropriate hospitalizations that ranged from 6% to 19%, whereas studies of children have found rates of inappropriate admissions and/or hospital days ranging from 20% to 30%.

Our findings in a contemporary, community-based cohort indicate that a substantial proportion of patients admitted to ICUs have a very low likelihood of death and may not require ICU care. Our findings further indicate that, even within a single geographic region, substantial variability exists in how ICUs are used in individual hospitals. Although such variability may, in part, be driven by unmeasured clinical differences, differences in physician and hospital practices probably are a much more important factor. Hospitals may have very different thresholds for admitting patients to ICUs that may reflect differences in administrative policies or levels of staffing on non-ICU wards. For example, the lower rate of low-severity ICU admissions that we observed in major teaching hospitals suggests that the availability of house staff may allow these hospitals to effectively treat sicker patients in non-ICU settings. Alternatively, differences between hospitals may reflect differences in ICU triage due to hospital occupancy and capacity. Hospitals may preferentially admit patients to the ICU to maintain high ICU occupancy. Although such practices may serve to maintain clinical skills of ICU practitioners or reassure staff that ICU resources are available, they also may lead to higher hospital costs without discernible impact on patient outcomes. Indeed, previous studies suggest the potential cost savings of treating low-risk patients in non-ICU settings.

In interpreting our findings, several potential methodological limitations should be considered. First, we did not examine directly the indication for ICU admission or the clinical appropriateness of each admission. Some patients may have been admitted to receive monitoring and/or treatment that could only be provided in ICUs. However, analyses in a subset of study patients indicated that most patients with low severity of illness did not receive ICU-specific interventions. Moreover, other studies that examined use of ICU-specific interventions have found that patients with lower severity of illness have a lower likelihood of receiving such treatment during their ICU stays. For example, Zimmerman et al found that Acute Physiology Scores on admission were directly related to the use of ICU interventions by the second day, and that patients with lower scores were more likely to be candidates for intermediate care units.

Second, our assessments of severity of illness and risk of in-hospital death were based on a normative analysis of patients admitted to the ICU (ie, patients were identified as having a low risk of death because the actual rate of death was low). Thus, our analysis would overestimate the true proportions of low-severity admissions if admission to the ICU led to lower mortality rates. However, the effectiveness of ICU care in patients with low severity of illness is unknown,
and several studies indicate that higher-intensity care may be associated with poorer hospital outcomes. In addition, our assessments of severity incorporated physiologic abnormalities during the first 24 hours of ICU admission. Assessments may have differed if only data available at the time of admission were used. However, previous studies have shown that APACHE III scores based on ICU admission data are generally similar, and that admission values of the APACHE III physiologic variables represent the most abnormal value nearly 90% of the time. Thus, it is likely that most patients who were classified as having low severity of illness in our study would have been so classified if APACHE III scores were based on admission values.

Third, the scope and definition of intensive care probably varied across hospitals. It is also likely that some hospitals had the capacity to provide some intensive care in non-ICU settings. Such organizational differences may be partly responsible for some of the variation in low-severity admissions across hospitals. Nonetheless, there is also substantial overlap across hospitals in the types of services that would be provided only in an ICU (eg, pulmonary artery pressure monitoring and use of certain vasoactive medications), and admission to an ICU has explicit implications with respect to hospital charges.

Fourth, although low-severity admissions accounted for an important proportion of total days of care, direct estimates of hospital and ICU costs were unavailable. Thus, implications of our findings on actual resource use are uncertain. Lastly, we had no information on health insurance and, as a result, were unable to examine potentially important effects of managed care and captitation on ICU admission practices.

Results of our study may have important implications for improving hospital efficiency and decreasing health care costs. The degree of variation across hospitals suggests that decisions to admit patients to ICUs may be subject to much discretion. Because the benefits of ICU care in such patients are unproven, efforts to decrease variability, such as explicit clinical criteria for ICU admission and decision aids to identify patients with low severity of illness that are based on quantitative measures, would be expected to improve the cost-effectiveness of care. The use of similar methods in patients presenting for evaluation of chest pain indicates that patients who are unlikely to benefit from ICU care can be successfully identified and triaged to lower-cost settings. Moreover, the small number of diagnoses that accounted for a major proportion of the low-severity admissions in our analysis indicates that methods could be targeted to a few diagnoses and still have a substantial effect. Such highly focused methods may be more effective than previously developed generic guidelines that have identified general classes of patients who should be considered ICU candidates. Future studies should examine the impact of such protocols on patient outcomes and the cost of ICU care.

In addition, identification of factors responsible for variations in these admissions may suggest mechanisms for more efficient hospital triage and management strategies. Such factors are likely to include overestimation of risk in patients with low severity of illness, use of imprecise heuristics, fear of litigation from not admitting patients to the ICU if an adverse event occurred, and local practice patterns.

Our findings provide indirect evidence that a large proportion of ICU admissions are discretionary in nature and may be clinically unnecessary or inappropri-

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**Table 2. Use of ICU-Specific Treatments in 12,929 Patients Admitted From January 1 Through June 31, 1994**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Admissions, % of Patients</th>
<th>Postoperative</th>
<th>Nonoperative</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low-Severity (n = 1207)</td>
<td>Other (n = 4192)</td>
<td>P</td>
</tr>
<tr>
<td>Mechanical ventilation or intubation</td>
<td>4.3</td>
<td>22.3</td>
<td>.001</td>
</tr>
<tr>
<td>Invasive monitoring or treatment</td>
<td>43.4</td>
<td>49.8</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Intra-arterial pressure monitoring</td>
<td>1.9</td>
<td>10.8</td>
<td>&lt;.001</td>
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<tr>
<td>Cardiac pacing</td>
<td>0</td>
<td>0.2</td>
<td>.09</td>
</tr>
<tr>
<td>Electrical cardioversion</td>
<td>0</td>
<td>0.1</td>
<td>.45</td>
</tr>
<tr>
<td>Left-ventricular assist devices</td>
<td>0</td>
<td>0</td>
<td>.001</td>
</tr>
<tr>
<td>Pericardiocentesis</td>
<td>0</td>
<td>0</td>
<td>.001</td>
</tr>
<tr>
<td>Tamponade of varices</td>
<td>0.1</td>
<td>0.2</td>
<td>.59</td>
</tr>
<tr>
<td>Ventriculostomy</td>
<td>0.1</td>
<td>0.5</td>
<td>.04</td>
</tr>
<tr>
<td>Any of the above</td>
<td>43.6</td>
<td>50.9</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

**Pharmacologic and other therapies**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Admissions, % of Patients</th>
<th>Postoperative</th>
<th>Nonoperative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial drug infusion</td>
<td>0.0</td>
<td>0</td>
<td>.001</td>
</tr>
<tr>
<td>Intravenous vasoactive drugs</td>
<td>7.4</td>
<td>19.3</td>
<td>&lt;.001</td>
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<tr>
<td>Intravenous antiarrhythmic drugs</td>
<td>0.2</td>
<td>1.6</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Thrombolytic agents</td>
<td>0.1</td>
<td>0.2</td>
<td>.42</td>
</tr>
<tr>
<td>Intravenous anticonvulsants</td>
<td>0.0</td>
<td>0.4</td>
<td>.03</td>
</tr>
<tr>
<td>Intravenous mannitol hexanitrate</td>
<td>0.1</td>
<td>0.5</td>
<td>.04</td>
</tr>
<tr>
<td>Rapid blood transfusions</td>
<td>0.0</td>
<td>0.7</td>
<td>.004</td>
</tr>
<tr>
<td>Rapid intravenous fluid replacement</td>
<td>0.2</td>
<td>1.1</td>
<td>.002</td>
</tr>
<tr>
<td>Intravenous treatment of acid-base abnormalities</td>
<td>0.1</td>
<td>0.9</td>
<td>.003</td>
</tr>
<tr>
<td>Barbiturate anesthesia</td>
<td>0.0</td>
<td>0.1</td>
<td>.23</td>
</tr>
<tr>
<td>Any of the above</td>
<td>7.9</td>
<td>21.5</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

* ICU indicates intensive care unit. Ellipses indicate not applicable.
ate. Given the increasing proportion of hospital care being financed through capitated arrangements, hospitals and physicians have new incentives to develop and implement clinical criteria to decrease variation in ICU admission practices by identifying patients in whom ICU care may not be effective. The impact of such changes in practices on the cost and quality of care should be evaluated.

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