ICU Bed Supply, Utilization, and Health Care Spending
An Example of Demand Elasticity

Intensive care is a substantial financial burden on the US health care system, with spending on critical illness exceeding $80 billion per year, approximately 3% of all health care spending and nearly 1% of the gross domestic product. In contrast, the United Kingdom spends only 0.1% of its gross domestic product on critical care services, with no evidence of worse patient outcomes and similar life expectancies as in the United States. Although there are many differences between these 2 countries, one significant difference is intensive care unit (ICU) bed supply. The United States has 25 ICU beds per 100 000 people, as compared with 5 per 100 000 in the United Kingdom. As a result, ICU case-mix differs substantially. In the United Kingdom, the majority of ICU patients are at high risk for death, whereas in the United States, many patients are admitted to the ICU for observation. At the same time, compared with patients in the United Kingdom, substantially more patients in the United States die in the ICU, suggesting that increased bed availability appears to reduce the incentive to keep dying patients out of the ICU.

The apparent influence of ICU bed supply on ICU bed utilization brings forward the concern of demand elasticity in the ICU, the notion that ICU beds create their own demand. In classical economics, demand elasticity measures how much the demand for a good or service changes in response to changes in another related factor. Demand elasticity is usually considered in terms of price; as price decreases, demand increases. However, it also is relevant to think of demand elasticity in terms of the supply of the good or service. Just as the creation of a new lane on the interstate highway can lead to increased traffic as new drivers seize the opportunity to travel on the larger road, new critical care beds can lead to increased use. As supply constraints are removed, clinicians are more likely to use the service, even for patients unlikely to benefit.

Under a model of demand elasticity, the case mix of patients admitted to the ICU might change depending on bed availability (Figure). Ideally the target population for ICU admission would be those patients who are critically ill and have the greatest probability of benefiting from ICU care. In the setting of demand elasticity, with increased ICU bed supply, there would be more ICU admissions for patients unlikely to benefit, including those who are not as critically ill and those who are critically ill but unlikely to survive regardless of ICU care. These patients might more appropriately receive care elsewhere. The reverse would be true in settings of low ICU bed supply because there would be greater incentive to keep these patients out of the ICU.

Most practicing intensivists observe the effects of ICU demand elasticity every day. When the physician is called to evaluate a patient with physiological deterioration in the non-ICU setting, such as a medical floor, the path of least resistance is to transfer the patient to an open ICU bed. Yet when the ICU is full, the physician may spend more time convincing concerned medical teams that the patient is safe in the non-ICU setting. Alternatively, if the patient is clearly at the end of life and a sensitive discussion of goals of care is needed, that discussion will often happen in the non-ICU setting when the ICU is full, but will be deferred to ICU if empty beds are available. Although the need for an ICU bed should be based primarily on the clinical status of the patient, in reality the need changes depending on ICU bed availability.

Several empirical studies support this notion. In addition to the international differences in ICU utilization, there is substantial variability in ICU utilization across hospitals within countries, even controlling for severity of illness. In a study conducted in the US Veterans Affairs Health system, the rate of ICU admission for low-risk hospitalized patients (defined as a predicted in-hospital mortality of <2%) varied from 1.2% to 38.9%, and more than

<table>
<thead>
<tr>
<th>Illness severity</th>
<th>Survival</th>
<th>Bed Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Yes</td>
<td>Increased ICU admissions</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>Decreased ICU admissions</td>
</tr>
<tr>
<td>Low</td>
<td>Yes</td>
<td>Increased ICU admissions</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>Decreased ICU admissions</td>
</tr>
</tbody>
</table>

The left upper quadrant represents the target patient population for the intensive care unit (ICU), ie, patients who have high illness severity and survive with ICU care. The left lower quadrant represents the patient population that has low illness severity but who do not survive despite ICU care. The right upper quadrant represents patients with low illness severity but who do not survive—a rare occurrence in an ICU population. Under a model of demand elasticity, the populations in the left lower quadrant and the right upper quadrant will increase in the ICU with high ICU bed availability and decrease if there is low ICU bed availability.
half of all ICU admissions were in this low-risk group. In a Canadian study examining outcomes of patients in wards after rapid response calls, calls that occurred during times of ICU bed scarcity were less likely to result in an ICU admission and more likely to result in the institution of comfort measures and death on the ward. The presence of demand elasticity in decisions regarding ICU care has major implications for health care delivery and financing. Primarily, this indicates it is possible to reduce the costs of US hospital care by constraining ICU bed supply, perhaps through certificate of need laws or other legislation. There is little evidence that low-risk patients gain a benefit from treatment in the ICU. Yet for hospitals, ICU beds contribute substantially to their overall fixed costs, costs that must be borne by all patients, not just those treated in the ICU. By decreasing ICU bed supply, health care costs could be reduced not only by preventing unnecessary ICU use but also by reducing the overall cost of hospital care. There are some limitations to reducing ICU bed supply as a cost-containment strategy. Fewer ICU beds means less ICU availability for care during disasters and pandemics. Yet it is unlikely there will ever be enough ICU beds for a true pandemic. Additionally, the ICU may provide benefits that extend beyond mere survival, such as family satisfaction and quality of death for the decedent. In that case, physicians must decide if the ICU is the most cost-effective and only place to achieve those benefits. There is no easy solution to controlling health care costs. Further research is needed to better understand the relationship between ICU supply and the demand for critical care. Yet with no action, the problem will certainly get worse. Between 2000 and 2005, critical care bed supply in the United States increased by 7%, with concomitant increases in ICU-related expenditures. It is reasonable to ask what gains in quality were obtained with this increase, particularly because the United States already has more ICU beds per capita than nearly any other nation. Without action, it is likely that the US health care system will continue to experience unconstrained growth in intensive care costs, with little to show for this investment.

ARTICLE INFORMATION
Conflict of Interest Disclosures: Both authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Dr Kahn reports provision of consultancy services to the US Department of Veterans Affairs and in-kind research support from the Cerner Corp. Dr Gooch reports no disclosures.

REFERENCES