The High Cost of Low-Acuity ICU Outliers

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EXE Cutive S ummary

Direct variable costs were determined on each hospital day for all patients with an intensive care unit (ICU) stay in four Phoenix-area hospital ICUs. Average daily direct variable cost in the four ICUs ranged from $1,436 to $1,759 and represented 69.4 percent and 45.7 percent of total hospital stay cost for medical and surgical patients, respectively. Daily ICU cost and length of stay (LOS) were higher in patients with higher ICU admission acuity of illness as measured by the APACHE risk prediction methodology; 16.2 percent of patients had an ICU stay in excess of six days, and these LOS outliers accounted for 56.7 percent of total ICU cost. While higher-acuity patients were more likely to be ICU LOS outliers, 11.1 percent of low-risk patients were outliers. The low-risk group included 69.4 percent of the ICU population and accounted for 47 percent of all LOS outliers. Low-risk LOS outliers accounted for 25.3 percent of ICU cost and incurred fivefold higher hospital stay costs and mortality rates. These data suggest that severity of illness is an important determinant of daily resource consumption and LOS, regardless of whether the patient arrives in the ICU with high acuity or develops complications that increase acuity. The finding that a substantial number of long-stay patients come into the ICU with low acuity and deteriorate after ICU admission is not widely recognized and represents an important opportunity to improve patient outcomes and lower costs. ICUs should consider adding low-risk LOS data to their quality and financial performance reports.
INTRODUCTION
Intensive care units (ICUs) serve high-acuity patients with complex and life-threatening illnesses. The number of ICU beds in the United States has increased despite overall decreases in total hospital beds (Halpern, Pastores, and Greenstein 2004), likely reflecting higher inpatient acuity. ICU costs are three- to fourfold higher than care costs in general medical-surgical wards (Rapoport et al. 2003). ICU beds account for approximately 10–15 percent of inpatient beds, but ICU costs account for one-quarter to one-third of all inpatient costs (Kahn 2006). The higher cost of ICU care reflects both higher staffing ratios and greater consumption of materials and services (Dasta et al. 2005; Weber et al. 2003). Rapoport et al. (2003) reported that 85 percent of ICU costs are explained by ICU length of stay (LOS). The literature demonstrating the importance of acuity of illness on ICU admission as a predictor of ICU LOS is extensive (Zimmerman et al. 2006b; Vasilevskis et al. 2009; Knaus et al. 1993). However, little is known about factors that affect daily ICU costs. The present study examines ICU costs at four hospitals in a large urban health system. The goals of the study were to define the contributors to ICU daily variable cost, understand how costs change over the duration of the ICU stay, and evaluate the effect of illness acuity on daily cost.

METHODS
All patients discharged from four Banner Health, Phoenix, hospitals’ ICUs between July 1 and December 31, 2007, were eligible for inclusion in the study. Of the four ICUs, three were general medical-surgical units and one was a neurologic ICU. Detailed financial and clinical data were obtained on all patients; those for whom the hospitals had not gathered complete data were excluded from the analysis. For patients with more than one ICU stay during the same hospitalization, only data from the first stay were analyzed.

Financial data were obtained from the TSI cost accounting system. Direct variable costs were determined using actual incurred costs, and labor costs of direct care providers were treated as variable costs. Total care provider salaries for each cost center were allocated to specific services (e.g., ICU or general ward care per patient day, respiratory care per hour of service). Consumable supplies were classified as direct variable costs and assigned to individual patients on the day of use. Reusable equipment (e.g., ventilators, infusion pumps) costs were classified as direct fixed cost. Direct fixed and indirect costs were allocated to individual patients using consistent department-specific allocation formulas. Direct fixed and indirect costs were used to estimate average daily ICU and floor total costs for patients from each institution. However, only direct variable costs were included in subsequent analyses, as these reflect actual accrued costs and thus potential cost savings. Individual patient costs (e.g., labor, supplies, pharmacy, laboratory) for each hospital day were allocated to 21 cost categories. The presence of an ICU labor cost entry was used to identify ICU days. All costs incurred on an ICU day were included in ICU costs except for emergency department, operating room, and catheterization laboratory costs. A similar
approach was used to calculate general medical-surgical ward costs. Operating room (OR) costs were subtracted from daily costs, as these are unrelated to care received in the ICU or on the general ward. OR costs include those incorporated into the surgery/anesthesia cost center and supplies and medications used in the OR, which are accounted for in separate cost centers. The latter costs were estimated by subtracting average daily supply and pharmacy costs on non-OR ICU days from those incurred on OR ICU days. OR days were identified by OR cost center entries in excess of $500. OR cost center entries lower than $500 were assumed to represent costs incurred during an earlier surgery (delayed billing) or in anticipation of a surgery that did not occur (canceled case). ICU supply and pharmacy costs on OR days were assumed to be equal to average daily supply and pharmacy costs for non-OR ICU days.

Patients were classified into three different acuity groups on the basis of their predicted mortality on admission to the ICU. Low-risk patients had predicted hospital mortality <10 percent, medium-risk patients between 10 and 50 percent, and high-risk patients >50 percent. The APACHE III methodology (Cerner, Kansas City, Missouri) was used to calculate predicted mortality (Zimmerman et al. 2006a). The APACHE system uses in its algorithms ICU admission diagnosis, chronic health status, and illness severity in the first ICU day. Seventeen physiologic variables are used to calculate illness severity. The APACHE methodology shows both good discrimination and calibration and is used extensively in ICU outcomes assessment (Zimmerman et al. 2006a; Breslow and Badawi 2012; Keegan, Gajic, and Afessa 2011).

**Analysis**

Three separate analyses were performed. The first analysis was an observational study of direct variable and total costs in the four facilities. ICU direct variable cost and the contribution of each ICU cost category were determined for each patient for each ICU day. Daily direct variable general ward costs were determined using the same methodology, as were daily ICU total cost calculations, which also include direct fixed costs and indirect costs. These costs were then averaged to calculate average daily costs for each facility. The contribution of ICU direct variable cost to total hospital stay direct variable cost was determined by calculating the average ICU and general ward stay cost and the average OR cost for patients having surgery. ICU and general ward stay costs were obtained by multiplying average daily ICU and general ward costs by average ICU and ward LOS. OR direct variable costs included OR cost center entries and OR supply and pharmacy costs, as calculated using the methodology described previously. For nonsurgical patients, the percentage of total hospital direct variable cost attributed to the ICU stay was determined by dividing total ICU costs by the sum of total ICU and floor costs. For surgical patients, total ICU direct variable costs were divided by the sum of ICU, floor, and OR direct variable costs.

The second analysis evaluated daily cost changes over the duration of an ICU stay to determine whether daily costs for early ICU days are greater than for later ICU days, a commonly held
assumption (Rapoport et al. 2003). For this analysis ICU daily direct variable cost for each patient was calculated by day in the ICU (e.g., ICU day 1, ICU day 2, ICU day 3, . . . , ICU day n). All first-day direct variable costs were then summed and divided by the number of patients with first-day cost data to compute average day 1 cost. Second and subsequent day average costs were calculated in the same manner.

The third analysis examined whether severity of illness affects average daily ICU direct variable cost and average total ICU and hospital stay direct variable cost. Average ICU daily direct variable cost was calculated separately for low-, medium-, and high-acuity patients. Average daily labor costs were used in this analysis, as no data capture actual time spent by individual providers for specific patients. Banner ICU nurses generally care for two patients, with the occasional high-acuity patient requiring a full-time nurse. Average ICU stay direct variable costs for low-, medium-, and high-acuity patients were determined by multiplying average ICU LOS for each group by the average ICU daily direct variable cost computed for that cohort. Average total hospital costs for each group were determined by adding average ICU and general ward care costs. We performed similar analyses on low-acuity patients with short and long ICU stays (short stay defined as six days or less), as we have reason to believe that patients only remain in the ICU for long stays if they have significant ongoing problems.

RESULTS
A total of 2,784 patients were discharged from the four ICUs during the study period. We obtained both financial and APACHE data for 2,056 of the eligible patients, and these patients constituted the study population. Key population demographic data were as follows:

- Age:
  - Mean age 58 ± 19 years
- Gender:
  - 53.5 percent male
  - 46.5 percent female
- Race/ethnicity:
  - 71.5 percent white
  - 16.1 percent Hispanic
  - 5.4 percent African American
  - 4.7 percent Native American
  - 1.7 percent unknown race/ethnicity
  - 0.6 percent Asian

The ICU mean admission APACHE score was 46 ± 21.5, with a hospital mortality of 7.68 percent. The top four ICU admission diagnoses were respiratory medical, other; diabetic ketoacidosis; coronary artery bypass graft; and cerebrovascular accident.

Average daily ICU direct variable cost was $1,597 across the four ICUs (range $1,436 to $1,759), and average daily general ward direct variable cost was $683 (range $632 to $721). ICU direct variable cost was approximately 50 percent of total average daily cost (average daily cost, including fixed and indirect costs, ranged from $2,833 to $3,627 across the four facilities). Labor (nursing and other staff) accounted for 56.2 percent of daily ICU direct variable cost. Pharmacy, lab/blood, and respiratory therapy costs were significant contributors, representing 15.9 percent, 7.3 percent, and 8.9 percent of
daily direct variable cost, respectively. Average ICU LOS was 4.06 days (sd 4.81 days), and average floor LOS, for patients with a floor stay, was 5.52 days (4.13 days for all patients). The average direct variable ICU stay cost was $6,488 per patient, and the average direct variable general ward stay cost was $2,833. Of the patient population studied, 488 (23.7 percent) underwent surgery during their hospitalization. Surgical costs averaged $5,099 per patient. ICU direct variable costs comprised 69.4 percent and 45.7 percent of total hospital direct variable cost for medical and surgical patients, respectively.

To evaluate changes in daily cost over the duration of the ICU stay, daily costs were examined as a function of ICU day. Exhibit 1a shows the number of study patients with ICU cost data as a function of ICU day. Large numbers of patients had cost data for the early ICU days (e.g., days 1–3), with fewer patients experiencing stays in excess of six days. Only 4.5 percent of patients had an ICU stay of more than 14 days. Daily cost data are shown in Exhibit 1b. Overall, costs changed little as a function of ICU day. In some ICUs we found a tendency for costs in later days to be higher than in earlier days. This trend is best explained by examining daily pharmacy and respiratory costs, which reflect actual resource utilization (Exhibits 2a and 2b). Both pharmacy and respiratory costs increased over the first four ICU days and remained elevated thereafter. Other component costs showed little appreciable change over time.

To assess whether acuity of illness on admission to the ICU affects ICU daily direct variable cost, patients were divided into three groups using APACHE-predicted mortality ranges of <10 percent, 10–50 percent, and >50 percent. Of the study population, 69.4 percent were in the low-acuity group (range 57.1–90.3 percent), 26.6 percent were in the moderate-acuity group, and 4 percent were in the high-acuity group (Exhibit 3a). The low-acuity patient average daily ICU cost was $1,471, the middle-acuity average was $1,604, and the high-acuity average was $1,936 (Exhibit 3b). Average ICU LOS was 3.36, 5.52, and 6.61 days for low-, medium-, and high-acuity patients, respectively. Longer LOS combined with higher daily costs resulted in higher total ICU stay costs and higher total hospital stay costs (ICU plus general ward) for the higher-acuity patients, with average total hospital stay direct variable costs of $7,740, $12,459, and $15,921, respectively, for the three groups (Exhibit 3c). The percentage of total hospital non-OR costs attributable to the ICU stay was lowest in the low-acuity group (65.7 percent), intermediate in the moderate-acuity group (73.9 percent), and highest in the high-acuity group (80.4 percent). Despite having significantly lower per patient costs, low-acuity patients accounted for 54.4 percent of total ICU costs, while medium- and high-acuity patients accounted for 37.8 percent and 7.9 percent of total ICU costs, respectively.

Because low-acuity patients accounted for more than two-thirds of the ICU patients and more than half of all ICU direct variable costs, we examined this group in greater detail. On average, 88.9 percent of low-risk patients had an ICU LOS less than or equal to six days, and 11.1 percent had stays...
longer than six days (the range across the four ICUs was 5.4–19.2 percent). While the percentage of patients with long stays (> six days = LOS outliers) was lowest in the low-risk population (11.1 percent vs. 26.7 percent in the medium-risk and 34.1 percent in the high-risk populations), low-risk patients accounted for 47.7 percent of all LOS outliers (Exhibit 4). Average ICU daily direct variable cost for low-risk LOS outliers was higher than for low-risk patients whose ICU stay was short ($1,605 vs. $1,409). ICU stay costs were
sevenfold higher for low-risk outliers ($21,142 vs. $3,095), while total hospital stay costs were 4.5-fold higher ($25,486 vs. $5,515). Low-risk LOS outliers accounted for 25.3 percent of all ICU costs. Moreover, these outliers also had fivefold higher severity-adjusted mortality (raw vs. predicted mortality).

**DISCUSSION**

This study examined ICU costs in four Phoenix-area hospitals. Daily ICU direct

**EXHIBIT 2**

**Resource Utilization**

A. Average ICU pharmacy direct variable cost, by ICU day

![Pharmacy Costs](image)

B. Average ICU respiratory direct variable cost, by ICU day

![Respiratory Costs](image)
variable costs averaged $1,597, which was almost 2.5 times higher than daily floor cost. ICU costs were fairly consistent across all four facilities. Labor accounted for slightly more than half of total daily cost. Pharmacy and respiratory costs were the next largest contributors and varied depending on acuity of illness. ICU daily cost was similar for all ICU days, with a tendency to be lower in the first two ICU days, once OR-related costs were excluded from true ICU costs. Acuity of illness on ICU admission, as reflected in APACHE-predicted mortality, was a major determinant of average daily ICU cost and total ICU costs.
and hospital stay cost, reflecting both higher daily resource consumption and longer ICU and general ward stays in sicker patients. The majority of ICU patients have low predicted mortality on ICU admission. However, more than 10 percent of these lower-acuity patients ended up with ICU stays of longer than six days. An observed fivefold increase in mortality in this subset of low-acuity patients suggests prolonged stays may be due to complications. These low-risk outliers had higher ICU daily cost and dramatically higher ICU and hospital stay costs.

For patients requiring ICU admission, their ICU care accounts for the majority of total hospital direct variable cost. ICU costs were more than twice total floor costs. This primarily reflects the difference in daily cost in the different environments, as total ICU days were almost identical to total floor days (average LOS 4.06 and 4.13, respectively). ICU costs represented a smaller fraction of total hospital cost in surgical patients due to the added OR costs but still approached 50 percent of total cost. Labor accounts for the majority of ICU cost, reflecting the number of skilled providers required to care for these high-acuity patients (Kahn 2006). In the Banner Health system, the standard patient-to-nurse ratio in the ICU is predominantly 2:1, against 4–6:1 on the general wards. Pharmacy costs accounted for 16 percent of daily cost, reflecting the large number and high cost of medications ICU patients receive. Respiratory costs were almost threefold higher than floor respiratory costs. Both medication and respiratory average daily cost

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**EXHIBIT 4**

**ICU LOS Outliers**

![Bar chart showing ICU LOS Outliers]

- Low-acuity patients
- Mid-acuity patients
- High-acuity patients

<table>
<thead>
<tr>
<th>Outliers as a % of the total ICU population</th>
<th>% of total LOS outliers per acuity category</th>
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Note: Although the percentage of patients with long stays was lowest in the low-acuity population, those patients accounted for almost half of all ICU LOS outliers.
patients have a fairly low mortality risk (Knaus et al. 1991). We found that fully two-thirds of patients had predicted hospital mortality less than 10 percent. Lower-risk patients also have a shorter predicted ICU LOS. LOS is the major determinant of ICU cost (Rapoport et al. 2003), and patients with a long ICU stay account for a disproportionate amount of total ICU cost (Martin et al. 2005). In the study population, 16 percent of patients had an ICU stay longer than six days’ duration. We define these patients as LOS outliers, and they accounted for 57 percent of total ICU cost. Illness severity at the time of ICU admission was a good predictor of the risk that a patient would become an LOS outlier, with mid- and high-acuity patients having 2.4- and 3.1-fold incidences, respectively. However, 11.1 percent of low-risk patients had an ICU stay greater than six days. That incidence, when combined with the predominance of this population, resulted in almost half of all LOS outliers coming from the low-risk group. Low-risk LOS outliers accounted for 25 percent of total ICU costs. The observed fivefold higher mortality of this subset of low-acuity patients, compared to short-stay low-acuity patients when adjusted for individual patient mortality risk (actual to predicted mortality ratios), suggests that the long stay of these patients may have been due to complications. These patients also had higher average daily pharmacy, respiratory, and total costs (116 percent, 130 percent, and 20 percent higher, respectively), indicating higher resource consumption than the lower-acuity patients who had a less eventful ICU stay.

Prior studies of ICU cost have identified ICU LOS as a major determinant of overall cost (Rapoport et al. 2003; Kahn 2006), a finding confirmed in the present study. The ICU scoring system literature has highlighted the strong relationship between severity of illness and ICU LOS (Zimmerman et al. 2006b; Vasilevskis 2009; Knaus et al. 1993), and it is not surprising that average ICU (and floor) LOS in mid- and high-acuity patients in our study was 64 percent and 97 percent higher, respectively, than LOS in the low-acuity patients. The present study also demonstrates that daily ICU cost varies with patient acuity. We used the APACHE methodology to segment patients into three acuity groups based on predicted hospital mortality. Patients with a 10–50 percent predicted mortality incurred 10 percent higher average daily costs than those with a predicted mortality less than 10 percent, while those with a greater than 50 percent mortality risk incurred 28 percent higher average daily costs. Although prior studies have demonstrated higher care costs in older patients and those with chronic health problems (Carson and Bach 2002), our study demonstrates that acuity of illness predicts not only duration of time in the hospital but also amount of resources consumed on any given day. So while age and chronic health status may contribute to severity of illness, it is actually severity of illness that determines both daily resource consumption and the time course of recovery. The present study confirms prior observations that the majority of ICU costs increased markedly across the three acuity groups.
Our data suggest that costs are lowest on ICU days 1 and 2 and rise to a steady plateau thereafter. This finding is at odds with the perception of many hospital financial analysts, who often look only at daily cost numbers without factoring out the contribution of OR costs. The majority of surgical ICU patients undergo surgery the same day they are admitted to ICU, and the inclusion of these costs artificially elevates ICU costs for that day. Our data indicate that direct variable OR costs average $5,100 per surgical patient and $1,200 when spread over all ICU patients. When these OR costs are eliminated from ICU costs, average ICU costs are actually somewhat lower on the first ICU day. We attribute the observation of lower costs in the first two ICU days to the routine practice of admitting lower-acuity patients to ICU for observation. Most of these patients do not receive mechanical ventilation, cardioresuscitative medications, or broad-spectrum antibiotics—therapies in widespread use for higher-acuity ICU patients. Once these low-acuity patients leave the ICU after a day or two of observation, the patients who remain are those who are sick and need ongoing, resource-expensive ICU care.

Limitations

Direct variable costs were determined using actual labor and supply costs. Direct variable labor costs included all salaries and benefits of direct care personnel in each service area. Total direct care labor costs were divided by the number of patient days or hours of service provided and then allocated to individual patients based on the services they received each day. We chose to focus the study on direct variable costs, as these reflect true costs of care and are potentially amenable to future cost savings. Total average daily cost information was provided to illustrate that direct variable costs represented approximately 50 percent of total cost. Direct fixed costs included salaries for personnel not engaged in direct patient care (e.g., ward clerk) and nonconsumable supplies and devices. As in all cost accounting systems, decisions are made regarding what constitutes variable versus fixed expenses, and different health systems may allocate costs somewhat differently to specific cost centers. Because the same methodology was used for all analyses in our study, it is very unlikely that cost allocation strategies used by Banner Health account for the observed differences among the groups we report on in this study.

We examined only the first ICU stay in patients who had more than one ICU stay during a single hospitalization. This factor likely resulted in a minor underestimation of total stay costs and the percentage of costs attributable to the ICU. Another limitation is in how labor costs were allocated to individual patients. The Banner Health cost accounting system assumes equal staffing for all patients. The study ICUs generally use a 2:1 staffing ratio. Very high acuity patients are cared for by a single nurse. Even where one nurse cares for two patients, the staff routinely devote more time to sicker patients. As a result, the demonstrated impact of patient acuity on average daily, total ICU, and hospital cost almost certainly underestimates the true difference. For the
acuity of illness analysis we were limited to patients whose APACHE and cost data were both available. APACHE data were unavailable for approximately 25 percent of patients due to either missing physiologic data required for computation or an inability to match the patients in the two databases. Patient demographics and diagnoses in the APACHE subset of patients were similar to those of the entire population, and thus we have little reason to believe that selection bias contributed to the findings. Lastly, we had to estimate OR pharmacy and supply costs because these are not captured in the operating room/anesthesia charge center. We assumed that ICU supply and pharmacy costs incurred on OR days are similar to levels on other ICU days and that any differences represent OR-related use.

Implications
LOS outliers have a disproportionate effect on total ICU cost (Kaushal et al. 2007), and it is important for quality and financial analysts to review data for this subset of patients on a regular basis. Our data suggest this group is composed of two distinct populations: (1) those very sick on arrival to the ICU and (2) those with low mortality risk on admission who develop complications that extend their stay and increase their mortality. Prior studies have shown that high-acuity patients have long LOS (Zimmerman et al. 2006b); high costs are expected and may not be avoidable. In contrast, low-risk patients who develop complications that result in a long ICU stay represent an important target for quality improvement efforts. Avoiding complications in this population could reduce mortality, LOS, and cost. Banner Health observed a nearly 50 percent reduction in low-risk LOS outliers after implementing a tele-ICU care program (percentage based on internal Banner Health data). This experience indicates that many of these long stays may be avoidable. We encourage hospital leaders to segment the ICU population by mortality risk and quantify the incidence of LOS outliers in the three different populations. Low-risk LOS outlier rate is an important statistic that should be incorporated into ICU quality and financial scorecards, as these data provide valuable performance information.

Conclusions
High staffing ratios and the use of multiple complex therapies account for the high costs of ICU care. While illness severity affects resource use and therefore costs, the duration of the ICU stay is the most important determinant of overall ICU and hospital cost. Although high-acuity ICU patients have longer ICU stays, reflecting the disease burden on admission, a subset of lower-acuity ICU patients who develop complications represent an equally important group of long-stay, very costly patients. Costs attributed to high-acuity patients likely cannot be avoided. In contrast, preventing avoidable complications in low-risk patients can result in substantial savings. Stratifying patients by acuity can assist in predicting costs; however, identifying the etiologies underlying reasons for longer LOS in lower-acuity patients may provide greater opportunities for improvements in quality of care and financial performance.

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REFERENCES


When reading this article, I thought how the findings in it were not immediately apparent. It is easy to understand a correlation between high acuity and total costs incurred by a patient’s stay. However, as in most cases, when data are dissected and viewed through multiple lenses without preconceived notions, gems can be found. Neither a hospital nor its staff can predetermine the acuity levels of its admitting patients. However, when a patient enters its walls, measures can be taken to ensure that high quality is delivered in a cost-effective way. Determining that higher costs can be associated with lower-acuity patients who experienced complications during their stay allows the clinical and administrative staff to take actionable steps toward lowering costs and raising quality.

I have been involved in many projects initiated to lower length of stay (LOS), including developing better sepsis protocols, enhancing the case management function, and improving the discharge process. Each initiative, as with the project to anticipate possible complications associated with low-acuity patients discussed in the article, can be acted and improved on by the hospital.

This knowledge might be introduced to a hospital by asking the following questions:

1. Do we currently capture the needed data (variable ICU costs by LOS day and patient acuity suitable for stratification) where and how it is stored?
2. How do we determine who has the ability and responsibility to affect these metrics?
3. What complications are causing the extended length of stay for lower-acuity patients?

After determining what data and metrics are available, lowering the cost and length of stay by reducing or eliminating complications associated with low-acuity patients can be accomplished through the As-Is, To-Be process improvement approach. The As-Is phase includes documenting current processes in the ICU specific to lower-acuity patients and determining benchmark data points. The To-Be phase consists of establishing process and policy changes, roles and responsibilities, and quality goals. After determining the new processes, a gap analysis is performed that allows mapping from As-Is to To-Be. Upon completion of the gap analysis, a test should be conducted with a small subset of low-acuity patients. The implementation should be created and executed with best practices learned from the test phase.

Through their analysis, the authors identify a group of patients who incur additional costs and hypothesize that the additional costs are the result of complications during what otherwise would be a short visit. What is exciting about this discovery, unlike costs associated with higher acuity, is that the hospital staff can improve the length of stay and cost per day metrics through process and quality improvement approaches.