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Variation in use of intensive care for adults with diabetic ketoacidosis*

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Abstract

Objective—Intensive care unit (ICU) beds are limited, yet few guidelines exist for triage of patients to the ICU, especially patients at low-risk for mortality. The frequency with which low-risk patients are admitted to ICUs in different hospitals is unknown. Our objective was to assess variation in use of intensive care for patients with diabetic ketoacidosis (DKA), a common condition with a low-risk of mortality.

Design—Observational study using the New York State Inpatient Database (2005-2007).

Setting—159 New York State acute care hospitals.

Patients—15,994 adult (≥ 18) hospital admissions with a primary diagnosis of DKA (ICD-9-CM 250.1x).

Interventions—None.

Measurements and Main Results—We calculated reliability- and risk-adjusted ICU utilization, hospital length of stay (LOS), and mortality. We identified hospital-level factors associated with increased likelihood of ICU admission after controlling for patient characteristics using multilevel mixed-effects logistic regression analyses; we assessed the amount of residual variation in ICU utilization using the intra-class correlation coefficient. Use of intensive care for DKA patients varied widely across hospitals (adjusted range: 2.1% to 87.7%), but was not associated with hospital LOS or mortality. After multilevel adjustment, hospitals with a high

volume of DKA admissions admitted DKA patients to the ICU less often (OR 0.40, $p=0.002$, highest quintile compared to lowest) whereas hospitals with higher rates of ICU utilization for all non-DKA inpatients admitted DKA patients to the ICU more frequently (OR 1.31, $p=0.001$, for each additional ten percent increase). In the multi-level model, more than half (58%) of the variation in ICU admission practice attributable to hospitals remained unexplained.

Conclusions—We observed variation across hospitals in use of intensive care for DKA patients that was not associated with differences in hospital LOS or mortality. Institutional practice patterns appear to impact admission decisions and represent a potential target for reduction of resource utilization in higher use institutions.

Keywords

Diabetic Ketoacidosis; Delivery of Health Care; Physician's Practice Patterns

Introduction

Intensive care unit (ICU) beds are a limited resource and, as the population ages, the demand for critical care is projected to increase (1). However, few guidelines exist to help identify which patients should be admitted to an ICU and which can be effectively cared for elsewhere in the hospital (2-4). For some critical care diagnoses (e.g., vasopressor-dependent septic shock) the decision to admit a patient to the ICU may be clear, but for many low-risk diagnoses (e.g., gastrointestinal bleeding without shock, diabetic ketoacidosis (DKA)), which account for 39% of ICU admissions in the United States(5), the decision is less clear, resulting in variation in practice. Understanding the drivers of this variation—specifically, how much of it is explained by differences in patient characteristics and quantifiable hospital factors versus differences in institutional practice patterns or culture—is the first step towards identifying best practice and decreasing unwarranted variation in care.

Studying the variation in ICU admission practice across hospitals is challenging due to the heterogeneity of critical illness. Each institution is charged with providing care to widely differing populations of ill adults. Consequently, it is difficult to tease out whether variations in admission practice between hospitals arise from the use of differing triage strategies or, instead, from the use of similar triage strategies being applied to different patient populations. To minimize heterogeneity, therefore, we chose to study a single condition, DKA, a serious complication of diabetes mellitus (6). We selected DKA as it is an easily diagnosed condition that is almost exclusively present on hospital admission (rather than developing during hospitalization) and for which ICU admission is common (7), but not essential. Moreover, there are no guidelines regarding ICU admission for this population, but care itself is typically protocolized with relatively little room for clinician discretion (8).

Materials and Methods

Patients

We performed a retrospective study of all patients admitted to acute care hospitals in New York State from January 1, 2005 through December 31, 2007 using the Agency for Healthcare Research and Quality's State Inpatient Database (SID) (9). The SID contains administrative discharge information for all patients, regardless of insurance status or coverage provider, from all acute care hospitals in New York State.

Our cohort included adults (age ≥ 18) with a primary diagnosis of DKA. Patients were identified by the ICD-9-CM code 250.1 $\times$ as in other epidemiologic studies of DKA (10, 11).

Admission to an ICU was identified using resource utilization codes and could include admission to a coronary care unit (CCU); use of a stepdown or intermediate care unit was not included due to inconsistencies in the definition of such units and the absence of this information in our dataset (12). We refer to patients as having received intensive care during the hospitalization (rather than being triaged to the ICU) because the exact timing of ICU admission was not available to allow confirmation that DKA patients were directly admitted to the ICU from the emergency room. Available patient characteristics included demographic and socioeconomic information (age, gender, race, primary insurance provider, median income quartile for ZIP code of residence), the extent of chronic illness (using the Deyo modification of the Charlson comorbidity index) (13), and type of hospital admission (emergent or non-emergent).

Hospitals

We obtained characteristics of acute care hospitals in New York State by linking data from the SID to the Healthcare Cost Report Information System (HCRIS) from 2006 (14). Missing data were obtained from the American Hospital Association's Survey from 2007 (15). Hospital-specific data obtained from these sources included the number of hospital beds, percentage of hospital beds designated as critical care (including medical ICU, surgical ICU, CCU, and burn unit beds), teaching status of the hospital (defined based on resident to hospital bed ratio as "non-teaching" (no residents), "minor teaching" (<0.25 residents per bed), and "major teaching" (≥ 0.25 residents per bed) (16), the average hospital occupancy rate over a year, the average ICU occupancy rate over a year, and the location of the hospital (metropolitan and non-metropolitan, per the standard U.S. government classification). We also calculated the frequency of DKA in each hospital defined as the percentage of inpatients with a diagnosis of diabetes mellitus that had DKA, the total volume (absolute number) of DKA patients cared for, and the percentage of all non-DKA inpatients who received treatments in an ICU.

We excluded data from hospitals that admitted fewer than 10 patients with DKA over the 3-year time period ($n=16$) or had an average age of patients with DKA that was greater than the 95th percentile for all hospitals (48.0 years, $n=14$) or less than the 5th percentile (34.2 years, $n=13$). We also excluded data from hospitals that had an unusually high percentage (greater than the 95th percentile) of diabetic inpatients diagnosed with DKA ($>4.6\%$, $n=12$). Nine hospitals met more than one exclusion criterion.

Statistical Analyses

Our overall approach was to use multi-level models, nesting individual hospitalizations (with detailed information about each patient) within hospitals. Such models estimate the extent to which variance is explained at the patient and hospital level, allow for risk-adjustment to account for differences in patient co-morbidity, and allow for reliability-adjustment to account for variation due to chance inherent in situations in which hospitals admit relatively small numbers of patients (17, 18). These models also can adjust standard errors for these multiple sources of variance to allow valid statistical inferences and calculation of p-values in the presence of clustering.

We summarized the patient characteristics and hospital characteristics associated with admission to an ICU with a diagnosis of DKA. We first compared differences between groups using the Chi-square and Student's t-tests as appropriate. We then used multilevel mixed-effects logistic regression to identify the odds of ICU admission associated with individual patient- and hospital-level factors. All listed factors were included in the final multivariate model. We determined the variation in ICU utilization attributable to hospitals using the intra-class correlation coefficient (19); we compared the variation in a model

without adjustment for either known patient or known hospital level factors to a model that included both in order to determine the residual unexplained hospital-attributable variation.

We grouped hospitals into quintiles based on the overall frequency of ICU use for DKA in each hospital. We then assessed hospital length of stay (LOS) and reliability- and risk-adjusted hospital mortality for patients in hospitals with similar overall frequency of admission to ICU. We report median LOS (with interquartile range) due to the non-normal distribution of the outcome. We assessed the relationships between the ICU utilization rate of the hospital and (1) median LOS for patients in that hospital using the Spearman rank correlation coefficient and (2) adjusted hospital-specific mortality using linear regression in which we regressed each hospital's adjusted mortality rate on its adjusted ICU utilization rate.

All analyses were performed using STATA 11.1 (StataCorp LP, College Station, TX) and Microsoft Excel. Human subjects approval was obtained from Beth Israel Medical Center institutional review board (IRB #200-10). Funding for this study included Award Number K08AG038477 from the National Institute on Aging to Dr. Wunsch, K08HL091249 from the National Heart, Lung and Blood Institute to Dr. Iwashyna, and a New Investigator Award from the Canadian Institutes for Health Research to Dr. Scales.

Results

The cohort included 15,994 patient admissions to 159 hospitals (Table 1). The majority of hospitals (81.7%) were in a metropolitan setting and more than half of the hospitals were teaching facilities (57.2%). The hospitals had a median of 190 beds with ICU beds accounting for a median 9.4% (interquartile range (IQR) 7.6%-12.8%) of all hospital beds. A median of 11.8% (IQR 8.9%-19.0%) of all inpatient admissions were admitted to an ICU during their hospitalization. DKA patients made up 0.4% (median of hospitals 0.4% (IQR 0.3%-0.5%)) of all hospital admissions and 1.4% (median of hospitals 1.7% (IQR 1.0%-2.5%)) of ICU admissions in our cohort of hospitals.

Of the admissions for DKA, 52.6% were admitted to an ICU (Table 2). Patients admitted to an ICU tended to be younger (18.8% of ICU admissions vs. 16.8% of non-ICU admissions were <25 years old, $p_{unadj}=0.004$), white (49.7% of ICU admissions vs. 36.2% of non-ICU admissions, $p_{unadj}<0.001$), privately insured (31.1% of ICU admissions vs. 26.0% of non-ICU admissions, $p_{unadj}<0.001$), coming from a higher income ZIP code (40.1% of ICU admissions vs. 29.3% of non-ICU admissions were in the top two income quartile brackets, $p_{unadj}<0.001$), and admitted on the weekend versus a weekday (27.3% of ICU admissions vs. 24.6% of non-ICU admissions, $p_{unadj}<0.001$).

Use of intensive care for patients with DKA varied significantly across hospitals (Figure 1). The median risk- and reliability-adjusted frequency of admission to ICU was 54.8% with a range of 2.1% to 87.7%. After adjustment for clustering by hospital, several patient- and hospital-level factors were significantly associated with more frequent admission to the ICU (Table 3).

Patient Characteristics Influencing Variation in the Use of Intensive Care

The odds of admission to ICU were increased for patients who lived in a more affluent ZIP code (OR 1.19 for being in the highest or 2nd-highest income quartile versus the lowest, $p=0.033$), had more chronic illnesses (OR 1.09 for each additional Charlson index point, $p<0.001$), were admitted after an emergent presentation to the hospital (OR 1.79 compared with arriving as a non-emergent patient, $p<0.001$), or were admitted on the weekend (OR

1.14, $p=0.002$). The odds of admission to ICU were decreased for patients who were older ($p=0.002$) or non-white ($p=0.019$).

Hospital Characteristics Influencing Variation in the Use of Intensive Care

The only two hospital-level characteristics found to be associated with ICU use for DKA were the volume of DKA patients admitted over the 3-year period and the overall use of intensive care. DKA patients were less likely to be admitted to the ICU if they were in a hospital with a high volume of DKA (OR 0.40 for highest quintile versus lowest quintile, $p=0.002$). Overall higher use of ICU-level care for non-DKA hospital admissions was associated with more ICU utilization for DKA patients (OR 1.31 for each additional increase in ten percent of non-DKA ICU utilization, $p=0.001$).

Unexplained Variation in the Use of Intensive Care

The individual hospital accounted for more than one-fifth (21.3% (CI 17.4%-25.8%)) of variation in ICU use for DKA patients. After adjustment for known patient and hospital level factors, 58% of variability attributable to hospitals remained, leaving 12.3% (CI 9.7%-15.6%) of all variation in ICU utilization unexplained and attributable to hospitals.

Outcomes

The median hospital LOS was three days (range 1-6 days) and median reliability- and risk-adjusted hospital mortality was 0.7% (range 0.4%-3.4%) for all hospitals. There was no association between greater use of intensive care for patients with DKA and either hospital LOS (Spearman rank correlation coefficient, $r = -0.128$, $p=0.108$, Figure 2a) or hospital mortality (regression coefficient -0.002 ($-0.005, 0.001$), $p=0.24$, for the association of an increase in hospital mortality rate by 1% to an increase in ICU utilization by 1%, Figure 2b).

Discussion

There exists wide variation in the use of intensive care for patients with a primary diagnosis of DKA across New York State hospitals. Much of the variation in practice was due to identifiable patient and institutional factors. However, there was also persistent variation between hospitals that could not be explained by observed patient or hospital characteristics.

Some of the independent explanatory factors were consistent with the use of intensive care for patients with a higher severity of illness, for example for patients with a greater number of comorbidities. The volume of patients treated with DKA was also inversely correlated with the use of intensive care, consistent with the idea that care for DKA patients could be provided in other areas in hospitals where DKA may represent a more routine admission diagnosis. Other factors, however, such as greater use of intensive care for patients with higher socio-economic status or admitted to hospitals that use intensive care more frequently for non-DKA in-patient admissions, are not as clearly linked to quality of care decisions and may represent potential targets for decreasing potentially unnecessary intensive care use.

Much of the inter-hospital variability in ICU admission practices for patients with DKA could not be explained by available patient factors. This observation coupled with the finding that the overall frequency of admission of non-DKA in-patients to the ICU was one of the largest predictors of ICU utilization for DKA suggests that there are unmeasured institutional factors that impact decisions to admit patients to ICU. For example, hospitals that admit DKA patients to the ICU more frequently may have lower nurse-to-patient ratios on general medical floors or may have busier emergency departments with priority placed on fast transfer out of the emergency room prior to resolution of acidosis and stabilization.

Hospitals with lower ICU admission rates for DKA may have intermediate care units or step-down units to which DKA patients can be triaged.

We find it useful to stratify these potentially influential factors into those that are “structural” and those which are more about “culture”. Structural factors may include staffing patterns (nurse and physician) throughout the hospital or the presence of protocols to allow for continuous insulin infusions on general medical wards. Cultural factors may include prevailing attitudes such as “DKA should be cared for in an ICU because that’s the way it’s always been done at this hospital.” Enacting change in either type of factor is possible, yet each is fraught with its own challenges. Changing structural factors is theoretically easy to accomplish, but is often hampered by limited resources; for example, hiring more healthcare providers is expensive and approving new policies is time-consuming and labor-intensive. Altering culture requires buy-in from participants and is inherently challenging to foster.

Non-uniformity in practice has been shown to be undesirable in domains of healthcare other than the use of intensive care (20). In civilian trauma care, triage protocols designed to appropriately utilize resources have been shown to be effective in decreasing “over-triage” without negatively impacting outcomes when applied both in pre-hospital (21) and in-hospital (22) settings. Within hospital-based critical care, standardizing care to consistently implement optimal management strategies in the ICU can improve outcomes (23, 24).

We found no association between ICU utilization and either hospital length of stay or mortality. Studies of ICU triage decisions examining heterogeneous patient cohorts show overall worse hospital mortality for patients who did not receive intensive care (25). A recent observational study examined the impact of ICU triage decisions on medical and surgical patients and found that patients triaged to the ICU had lower 28-day and 3-month mortality than those patients denied admission (26). However, patients estimated to have a risk of hospital death of less than 5%—most DKA patients—did not have any survival benefit from admission to the ICU, consistent with our findings. We recommend caution when interpreting the present lack of association between ICU utilization and short-term patient outcomes for DKA. Our results are potentially consistent with two quite divergent interpretations: (1) that ICU admission is not beneficial for DKA patients or (2) that hospitals are appropriately triaging higher-risk patients into effective ICU therapy which is reducing any excess mortality they might otherwise have. In either case, use of intensive care would appear to have no association with outcome in an observational study such as our own.

Our study has several limitations. Our data are from New York State. While the population of New York represents 6.3% of the U.S. population (27) and we analyzed data from 159 hospitals, we cannot be sure that these findings extrapolate to other parts of the country (28). Patient information also came from an administrative dataset with the potential for misclassification of patients (29). However, other studies have used billing data to study DKA (10, 11) and the demographics of our cohort (specifically, the mean age and the percentage of patients with diabetes who had DKA) are consistent with other more detailed clinical cohorts (11, 30-32). Additionally, severity of acute illness was not captured in our dataset; thus, it is possible that DKA patients at some institutions were more critically ill than at others and may account for some of the variation in triage practice. We did not have access to information on the bed occupancy (either hospital or ICU) on the day of admission for each patient. Daily occupancy has been shown to impact the decision to admit an individual patient to the ICU (33-37). Moreover, there may be other factors (i.e., nurse-to-patient staffing ratios, the ability of non-ICU settings to provide close monitoring, or the availability of step-down units) that could be large drivers of hospital-level practice. Finally,

we were unable to confirm whether patients with a diagnosis of DKA who spent time in the ICU during their admission were admitted to the ICU directly from the emergency department. It is possible that some patients were initially triaged to the floor and subsequently required transfer to the ICU. Given the relative paucity of poor outcomes for DKA, however, we believe this need to “step-up” care and, hence, erroneous categorization is likely rare.

Conclusions

Intensive care is an expensive and limited resource. While the majority of intensive care research focuses on ways to improve delivery of care in the ICU, equally important is the question of who will benefit from intensive care. Our data, demonstrating the wide variability in use of intensive care for a group of relatively homogenous patients with low risk of death, suggest that some standardization of ICU admission criteria for specific sub-groups of patients may be an option. In order for these changes to occur, further studies are needed to investigate more fully the structure and staffing factors as well as hospital policies that may allow for some hospitals to make the most appropriate use of intensive care beds. A better understanding of these drivers of triage decisions, both for DKA patients as well as, potentially, other groups of hospitalized patients, will be an important step towards providing lower-cost, higher-quality standardized care.

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Figure 1.

Distribution of use of intensive care for patients with DKA across acute care hospitals in New York State (reliability- and risk-adjusted*).

* For reliability- and risk-adjusted rates of the use of intensive care, the expected value is the actual cohort ICU utilization rate

Figure 2A.

Median hospital length of stay for DKA patients in acute care hospitals in New York State, stratified by proportion of patients admitted to ICU with DKA in each hospital.*

* ■ = median hospital length of stay; bars show the 25th-75th percentile for all patients in each group

† For reliability- and risk-adjusted rates of the use of intensive care, the expected value is the actual cohort ICU utilization rate

Figure 2B.

Hospital mortality* for DKA patients admitted to acute care hospitals in New York State stratified by proportion of patients admitted to ICU with DKA in each hospital.

* Mortality for patients admitted to the hospital with DKA stratified by the hospital-level frequency of admission to ICU. For example, 13 DKA patients out of 1,772 patients in the 11 hospitals with intensive care use for DKA between 10-19% died resulting in a $13/1,772 = 0.73\%$ unadjusted mortality rate.

[†] For reliability- and risk-adjusted rates (mortality and use of ICU), the expected value is the actual cohort rate (mortality and ICU use respectively).

Table 1

Characteristics of acute care hospitals in New York State in 2006.*

<u>Hospital characteristic (n=159)</u>	
Location [†] , n (%)	
Non-Metropolitan	29 (18.3)
Metropolitan	129 (81.7)
Academic status, n (%)	
non-teaching (0 residents/bed)	68 (42.8)
minor teaching (<0.25 residents/bed)	32 (20.1)
major teaching (≥ 0.25 residents/bed)	59 (37.1)
Hospital beds, n (%)	
100	31 (19.5)
101-200	51 (32.1)
201-300	31 (19.5)
301-400	21 (13.2)
401+	25 (15.7)
Hospital bed occupancy [§] (%) median (25 th ,75 th percentile)	68.5 (54.2,81.5)
Percentage of hospital beds designated as ICU beds n (%)	
5%	9 (5.7)
>5-7.5%	29 (18.2)
>7.5-10%	54 (34.0)
>10-12.5%	26 (16.4)
>12.5-15%	41 (25.8)
>15%	9 (5.7)
ICU occupancy [§] (%) median (25 th ,75 th percentile)	71.3 (53.6,84.0)
Admission to ICU for non-DKA patients (%) median (25 th ,75 th percentile)	11.8 (8.7,19.0)
Patients admitted with DKA [‡] (n) median (25 th ,75 th percentile)	77 (43,130)

* data on hospital beds, ICU beds, and resident:bed ratios were obtained from 2008 AHA numbers for 6 of the 159 hospitals in whom 2006 HCRIS data was missing

[†] determined by Core Based Statistical Area; data not available for 1 of the 159 hospitals (0.6%)

[‡] over the 3 year time period of January 1, 2005 through December 31, 2007

[§] calculated as patient-days divided by available bed-days; data not available for 6 of the 159 hospitals (3.8%)

Table 2

Characteristics of patients admitted for DKA in acute care hospitals in New York State from 2005-2007, stratified by admission to ICU during the hospitalization.

Patient characteristic	Hospitalization without ICU (n=7,580)	Hospitalization with ICU (n=8,414)	p-value
Age, n (%)			
<25	1274 (16.8)	1579 (18.8)	0.004
25-49	4032 (53.2)	4419 (52.5)	
50+	2274 (30.0)	2416 (28.7)	
Gender *, n (%)			
Male	4065 (53.6)	4461 (53.0)	0.44
Female	3514 (46.4)	3953 (47.0)	
Race †, n (%)			
White	2679 (36.2)	4069 (49.7)	<0.001
Black	2799 (37.8)	2461 (30.1)	
Other	1919 (25.9)	1653 (20.2)	
Primary insurer, n (%)			
Medicare	1395 (18.4)	1622 (19.3)	<0.001
Medicaid	3180 (42.0)	2961 (35.2)	
Private Pay	1971 (26.0)	2615 (31.1)	
Self-pay	842 (11.1)	1029 (12.2)	
Other ‡	192 (2.5)	187 (2.2)	
Quartile of median income of home zip code ‡, n (%)			
1 st quartile	3449 (48.1)	2817 (35.8)	<0.001
2 nd quartile	1616 (22.6)	1902 (24.2)	
3 rd quartile	1342 (18.7)	1953 (24.8)	
4 th quartile	759 (10.6)	1203 (15.3)	
Charlson comorbidity index score §, mean (SD)	2.3 (0.9)	2.3 (0.9)	0.61
Admission type ¶, n (%)			
Non-emergent	313 (4.1)	331 (3.9)	0.53
Emergent	7267 (95.9)	8081 (96.1)	
Admission Day, n (%)			
Weekday	5713 (75.4)	6114 (72.7)	<0.001
Weekend	1867 (24.6)	2300 (27.3)	

* information on gender was not available for 1 patient

† information on race was not available for 414 (2.6%) patients in 39 (24.5%) hospitals

‡ "other" includes coding in the dataset as "no charge" or "other"

§ information on median income of home zip code was not available for 953 (6.0%) patients in 95 (59.7%) hospitals

§ calculated as described in Deyo et al, 1992(13)

// information on admission type was not available for 2 patients in 1 hospital

Table 3

Adjusted likelihood of admission to an ICU using multilevel mixed-effects logistic regression.*

	<u>Univariate Analysis</u>		<u>Multivariate Analysis</u>	
	<u>OR (95% CI)</u>	<u>p-value</u>	<u>OR (95% CI)</u>	<u>p-value</u>
<u>Patient Factors</u>				
Age				
<25	1		1	
25-49	0.83 (0.75,0.91)	<0.001	0.85 (0.77,0.94)	0.002
50+	0.85 (0.77,0.95)	0.003	0.83 (0.73,0.93)	0.002
Gender				
Male	1		1	
Female	1.06 (0.98,1.13)	0.131	1.02 (0.95,1.10)	0.61
Race				
Caucasian	1		1	
Black	0.75 (0.68,0.83)	<0.001	0.81 (0.73,0.90)	<0.001
Other	0.80 (0.72,0.90)	<0.001	0.86 (0.76,0.98)	0.019
Primary insurer				
Medicare	1		1	
Medicaid	0.95 (0.86,1.05)	0.30	0.97 (0.86,1.08)	0.56
Private Pay	1.02 (0.92,1.13)	0.68	1.00 (0.90,1.12)	0.94
Self-pay	0.91 (0.80,1.04)	0.161	0.93 (0.80,1.07)	0.32
Other [†]	0.64 (0.50,0.81)	<0.001	0.65 (0.50,0.85)	0.001
Median income quartile of home ZIP code				
1st quartile	1		1	
2nd quartile	1.08 (0.97,1.21)	0.140	1.03 (0.93,1.16)	0.55
3rd quartile	1.25 (1.12,1.40)	<0.001	1.19 (1.06,1.34)	0.004
4th quartile	1.34 (1.15,1.56)	<0.001	1.19 (1.01,1.40)	0.033
Charlson comorbidity index score	1.07 (1.03,1.11)	<0.001	1.09 (1.04,1.13)	<0.001
Admission type				
Non-emergent	1		1	
Emergent	1.76 (1.42,2.19)	<0.001	1.79 (1.43,2.24)	<0.001
Admission day				
Weekday	1		1	
Weekend	1.17 (1.08,1.27)	<0.001	1.14 (1.05,1.24)	0.002
<u>Hospital Factors</u>				
% ICU utilization for non-DKA patients (each add'l 10%)	1.49 (1.25,1.77)	<0.001	1.31 (1.12,1.54)	0.001
Location				
Non-metropolitan	1		1	
Metropolitan	0.91 (0.72,1.16)	0.46	1.04 (0.80,1.34)	0.77
Volume of DKA				
1st quintile	1		1	
2nd quintile	0.93 (0.59,1.45)	0.75	0.95 (0.58,1.57)	0.85

	<u>Univariate Analysis</u>		<u>Multivariate Analysis</u>	
	<u>OR (95% CI)</u>	<u>p-value</u>	<u>OR (95% CI)</u>	<u>p-value</u>
3rd quintile	0.49 (0.32,0.77)	0.002	0.53 (0.31,0.90)	0.020
4th quintile	0.48 (0.31,0.74)	0.001	0.61 (0.35,1.07)	0.085
5th quintile	0.25 (0.16,0.38)	<0.001	0.40 (0.22,0.72)	0.002
Hospital beds				
100	1		1	
101-200	0.81 (0.53,1.25)	0.34	1.26 (0.76,2.09)	0.36
201-300	0.53 (0.33,0.85)	0.009	1.30 (0.72,2.35)	0.38
301-400	0.38 (0.23,0.64)	<0.001	0.91 (0.48,1.73)	0.78
401+	0.34 (0.21,0.56)	<0.001	0.80 (0.43,1.51)	0.50
Percentage of hospital beds designated as ICU beds				
5%	1		1	
>5-7.5%	1.19 (0.54,2.65)	0.66	2.24 (0.96,5.18)	0.061
>7.5-10%	1.39 (0.65,2.98)	0.40	2.25 (1.00,5.07)	0.051
>10-12.5%	1.02 (0.45,2.28)	0.97	1.64 (0.71,3.81)	0.25
>12.5%	1.18 (0.54,2.56)	0.68	2.23 (0.97,5.16)	0.061
Teaching status				
Non-teaching	1		1	
Minor teaching (<0.25 residents/bed)	0.57 (0.39,0.83)	0.003	0.83 (0.57,1.21)	0.34
Major teaching (0.25 residents/bed)	0.38 (0.28,0.52)	<0.001	0.78 (0.52,1.18)	0.24
Hospital % occupancy (each add'l 10%)	0.81 (0.74,0.88)	<0.001	0.95 (0.86,1.05)	0.32
ICU % occupancy (each add'l 10%)	0.94 (0.89,0.99)	0.027	0.99 (0.94,1.04)	0.68

* multivariate analysis included 14,285 DKA admissions (89.3% of cohort) for which information on all variables was available

[†]“other” includes coding in the dataset as “no charge” or “other”