

National Study of U.S. Emergency Department Visits With Diabetic Ketoacidosis, 1993–2003

ADIT A. GINDE, MD¹
ANDREA J. PELLETIER, MS, MPH²

CARLOS A. CAMARGO, JR., MD, DRPH²

Patients with diabetic ketoacidosis (DKA) are often managed in the emergency department before hospital admission. DKA hospitalizations comprise a significant portion of health care costs for diabetes (1). Although mortality for DKA has fallen, it remains an important cause of diabetes-associated death, especially among younger patients with diabetes (2). Prior analyses of DKA have been single-center intensive care unit (ICU) studies or based on hospital discharges (3–5). Patients may, however, be treated in the emergency department and then admitted to a non-ICU setting or discharged; the frequency of these practices is not known. We sought to describe the epidemiology of emergency department visits with DKA.

RESEARCH DESIGN AND METHODS

We analyzed the emergency department component of the 1993–2003 U.S. National Hospital Ambulatory Medical Care Survey (NHAMCS). Our institutional review board waived review of this analysis. Methodological details are described elsewhere (6–8). Briefly, NHAMCS uses a four-stage sampling strategy covering geographic primary sampling units, hospitals within primary sampling units, emergency departments within hospitals, and patients within emergency departments. Hospitals were stratified by region, presence of emergency department, ownership type, and size. Within each stratum, hospitals were

selected with a probability proportional to the number of emergency department visits. Data were collected during randomly assigned 4-week periods. Data forms include demographic information, emergency department disposition (i.e., admission, transfer, and discharge), and up to three ICD-9 discharge diagnoses. For the present analysis, we identified DKA visits based on ICD-9 code 250.1x, the unique code for DKA, in any of the diagnosis fields. This methodology has been utilized in prior Centers for Disease Control (CDC) analyses (3,9).

We used Stata 9.0 software (StatCorp, College Station, TX) to determine nationally representative estimates and 95% CIs using assigned patient weights, which adjust for selection probability. Where the relative SE was >30% or estimates were based on <30 cases, data are reported only as the number of observations. We calculated rates based on U.S. Census Bureau, CDC, and NHAMCS data.

RESULTS

Between 1993 and 2003, DKA accounted for ~753,000 visits (95% CI 610,000–895,000) or an average 68,000 visits/year.

Table 1 shows patient and hospital characteristics of emergency department visits with DKA. Most DKA visits were evenly distributed among patients aged 10–50 years. The large majority of DKA patients (87% [95% CI 81–92]) were admitted, with most admissions to a non-ICU setting. DKA visit rates per 10,000

U.S. population were higher for black than white patients. Rates per 10,000 U.S. population and per 10,000 emergency department visits were otherwise similar across all demographic factors.

The rate of emergency department visits for DKA per 10,000 U.S. population with diabetes was 64 (95% CI 52–76). Among this population, there was no significant difference in visit rates between male (66 [95% CI 47–85]) and female (62 [46–78]) patients. There was a trend toward increased rate of visits among the black population with diabetes (92 [60–124]) compared with the white population with diabetes (59 [47–72]). Comparing the first 6 years of visits (1993–1998) with the last 5 years (1999–2003), we noted an increasing number of visits for DKA (Table 1) with a stable rate per 10,000 U.S. population with diabetes, from 59 (95% CI 42–76) to 69 (51–86).

CONCLUSIONS— We report the first national emergency department-based epidemiological study of DKA visits. Between 1993 and 2003, we found an increasing number of visits over time, but the rate remained relatively unchanged, suggesting that increased prevalence of diabetes accounts for the growth in DKA visits. The more recent estimate of 69 emergency department visits per 10,000 U.S. population with diabetes is lower than the CDC-reported rate of 84 hospital discharges for DKA during the same time period (3). Additionally, CDC data suggest a decrease in the rate of hospital discharges for DKA from 106 to 84 per 10,000 U.S. population with diabetes. These trends suggest an increased utilization of the emergency department in DKA management, a decreased incidence of DKA during hospital admission, or fewer “direct admissions” for DKA (bypassing the emergency department). The relative importance of these explanations requires further study.

Nevertheless, given its role at the front line of the acute health care system, the emergency department provides a unique perspective on DKA epidemiology. For example, we found that most

From the ¹Department of Emergency Medicine, Beth Israel Deaconess Medical Center, Boston, Massachusetts; and ²Massachusetts General Hospital, Harvard Medical School, Boston, Massachusetts.

Address correspondence and reprint requests to Adit A. Ginde, MD, Department of Emergency Medicine, Beth Israel Deaconess Medical Center, One Deaconess Road, WCC-2, Boston, MA 02215. E-mail: aginde@bidmc.harvard.edu.

Received for publication 22 March 2006 and accepted in revised form 14 June 2006.

Abbreviations: CDC, Centers for Disease Control; DKA, diabetic ketoacidosis; ICU, intensive care unit; NHAMCS, National Hospital Ambulatory Medical Care Survey.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

DOI: 10.2337/dc06-0627

© 2006 by the American Diabetes Association.

The costs of publication of this article were defrayed in part by the payment of page charges. This article must therefore be hereby marked “advertisement” in accordance with 18 U.S.C. Section 1734 solely to indicate this fact.

Emergency department visits with DKA

Table 1—Emergency department visits with DKA, according to patient and hospital characteristics, 1993–2003

Variable	n	Estimated total no. of cases	%	95% CI	Rate per 10,000 U.S. population (95% CI)	Rate per 10,000 ED visits (95% CI)
Year						
1993–1998	88	315,000	42	32–52	2 (1–3)	6 (4–7)
1999–2003	122	438,000	58	48–68	3 (2–4)	8 (6–10)
Age (years)						
<10	8	NC	NC	NC	NC	NC
10–19	37	165,000	22	14–30	4 (2–5)	12 (7–17)
20–29	38	135,000	18	12–25	3 (2–5)	7 (4–10)
30–39	49	180,000	24	16–32	4 (2–5)	10 (7–14)
40–49	32	93,000	12	7–18	2 (1–3)	7 (4–10)
50–59	17	NC	NC	NC	NC	NC
60–69	10	NC	NC	NC	NC	NC
70–79	13	NC	NC	NC	NC	NC
≥80	6	NC	NC	NC	NC	NC
Sex						
Male	96	370,000	49	39–59	3 (2–3)	7 (5–8)
Female	114	383,000	51	41–61	2 (2–3)	7 (5–9)
Race						
White	144	543,000	72	65–79	2 (2–3)	6 (5–8)
Black	61	180,000	24	17–31	5 (3–6)	8 (5–10)
Other	5	NC	NC	NC	NC	NC
Ethnicity						
Hispanic	18	NC	NC	NC	NC	NC
Non-Hispanic	154	551,000	73	65–81	2 (2–3)	8 (6–10)
Unknown	38	158,000	21	13–29	NA	7 (4–11)
Insurance						
Private	58	215,000	29	20–37	NA	5 (3–7)
Public	79	287,000	38	30–47	NA	8 (6–10)
Self-pay	33	119,000	16	9–23	NA	7 (4–10)
Other/unknown	40	132,000	17	11–24	NA	8 (5–12)
Region						
Northeast	40	112,000	15	9–21	2 (1–3)	5 (3–7)
Midwest	57	253,000	34	24–43	4 (2–5)	9 (6–12)
South	72	239,000	32	23–41	2 (1–3)	6 (4–8)
West	41	149,000	20	13–27	2 (1–3)	7 (5–10)
Urban status						
Urban	179	618,000	82	75–90	3 (2–3)	7 (6–9)
Nonurban	31	135,000	18	11–26	2 (1–3)	6 (3–8)
Disposition						
Admitted	174	651,000	87	81–92	NA	5 (4–6)
ICU	51	213,000	28	20–36	NA	14 (9–19)
Non-ICU	123	438,000	58	51–66	NA	5 (4–6)
Transferred	12	NC	NC	NC	NA	NC
Discharged	24	NC	NC	NC	NA	NC
Total	210	753,000	100	—	3 (2–3)	7 (6–8)

ED, emergency department; NA, not available; NC, not calculable due to $n < 30$ (see RESEARCH DESIGN AND METHODS).

emergency department visits for DKA led to hospital admission, with one in four to an ICU setting. This suggests that many DKA visits are sufficiently controlled during the emergency department visit to obviate a critical care admission, but clearly, emergency department visits for DKA require significant resource utilization. Future studies might focus on differences in clinical outcomes in the different disposition groups and cost analyses.

We found no significant difference in the rate of DKA per 10,000 emergency department visits by sex, race, ethnicity, or insurance status. We did, however, note a trend toward increased DKA visits among the overall and population with diabetes among blacks. The trend may be due, in part, to racial disparity or ketosis-prone type 2 diabetes in black patients (10). This finding will require continued surveillance.

Because the NHAMCS lacks identifiers, the data pertain to emergency department visits, not individual patients. Also, the NHAMCS data only contain information about actions during the emergency department visit, exclusive of prior events. Low sample size for a few subgroups precluded some comparisons. However, this combined database provides important information on outcomes that are known to be collected with accuracy.

In summary, we report the first national emergency department–based epidemiological study of DKA visits. The study provides excellent background data for future studies on resource utilization and for emergency department–based clinical trials. The emergency department provides a venue that offers a distinct and important perspective on diabetes and diabetes-related complications.

References

1. Javor KA, Kotsanos JG, McDonald RC, Baron AD, Kesterson JG, Tierney WM: Diabetic ketoacidosis charges relative to medical charges of adult patients with type 1 diabetes. *Diabetes Care* 20:349–354, 1997
2. Basu A, Close CF, Jenkins D, Krentz AJ, Natrass M, Wright AD: Persisting mortality in diabetic ketoacidosis. *Diabet Med* 10:282–284, 1993
3. National Diabetes Surveillance System: Diabetic ketoacidosis as first-listed diagnosis [article online], 2005. Available from <http://www.cdc.gov/diabetes/statistics/dkafirst/fig1.htm>. Accessed 18 March 2006
4. Freire AX, Umpierrez GE, Afessa B, Latif KA, Bridges L, Kitabchi AE: Predictors of intensive care unit and hospital length of stay. *J Crit Care* 17:207–211, 2002
5. Marinac JS, Mesa L: Using a severity of illness scoring system to assess intensive care unit admissions for diabetic ketoacidosis. *Crit Care Med* 28:2238–2241, 2000
6. McCaig LF, Burt CW: National Hospital Ambulatory Medical Care Survey: 2003 emergency department summary. *Adv Data* 358:1–37, 2005
7. Stussman BJ: National Hospital Ambulatory Medical Care Survey: 1993 emergency department summary. *Adv Data* 271:1–15, 1996
8. McCaig LF, McLemore T: Plan and operation of the National Hospital Ambulatory Medical Survey. Series 1: Programs and collection procedures. *Vital Health Stat* 34:1–78, 1994
9. Geiss LS, Herman WH, Goldschmid MG, DeStefano F, Eberhardt MS, Ford ES, German RR, Newman JM, Olson DR, Sepe SJ, Stevenson JM, Vinicor F, Wetterhall SF, Will JC: Surveillance for diabetes mellitus: United States, 1980–1989. *MMWR CDC Surveill Summ* 42:1–20, 1993
10. Umpierrez GE, Smiley D, Kitabchi AE: Narrative review: ketosis-prone type 2 diabetes mellitus. *Ann Intern Med* 144:350–357, 2006