BRIEF REPORT

Limited Communication and Management of Emergency Department Hyperglycemia in Hospitalized Patients

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BACKGROUND: Hyperglycemia is often overlooked and unaddressed in hospitalized patients, and early and intensive management may improve outcomes.

OBJECTIVE: To evaluate communication and early management of emergency department (ED) hyperglycemia.

METHODS: This was a retrospective cohort study of patients with an initial serum glucose ≥140 mg/dL at an urban, academic institution. We randomly selected cases from a consecutive sample of ED visits with at least 1 serum glucose result during a 1-year period. We recorded clinical data and compared the content of inpatient and ED-written discharge instructions.

RESULTS: Of the 27,688 initial ED glucose results during the study period, 3517 (13%) were 140-199 mg/dL, and 2304 (8%) values were ≥200 mg/dL. In our sample of 385 patients, 293 (76%) patients were hospitalized. Inpatient or ED discharge instructions informed 36 (10%) patients of their hyperglycemia and 23 (6%) of a plan for further evaluation and management. There was no difference between inpatient and ED instructions for either of these variables ($P = 0.73$ and 0.16, respectively). Overall, 107 (55%) patients with glucose values 140-199 mg/dL and 31 (16%) patients with glucose ≥200 mg/dL had no prior diabetes diagnosis. Only 61 (16%) received insulin in the ED for their hyperglycemia, and hyperglycemia was charted as a diagnosis in 36 (9%) cases.

CONCLUSIONS: Most ED patients with even mild hyperglycemia were hospitalized. Recognition, communication, and management of ED hyperglycemia were suboptimal and represent a missed opportunity to identify undiagnosed diabetes and to initiate early glycemic control for hospitalized patients. ***Journal of Hospital Medicine*** **2009;4:45–49.** © *2009 Society of Hospital Medicine.*

KEYWORDS: communication, diabetes, emergency medicine, hyperglycemia, public health.

While increasing evidence suggests that hyperglycemia during illness is associated with poor clinical outcome,[1,2] hyperglycemia in the hospital setting is often overlooked and unaddressed.[3,4] Early and intensive management of hyperglycemia may improve outcomes in hospitalized patients.[5–7] Emergency Department (ED) glucose values may present an early opportunity to identify hyperglycemic patients as having unrecognized glucose intolerance and improve early glycemic control for hospitalized patients. Serum glucose values are available for 18% of 110 million annual ED visits in the United States, and many others undergo capillary glucose measurements.[8] Although stressors and lack of fasting may contribute to ED hyperglycemia, communication and management should be similar.[5] In this

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study, we hypothesized that in less than 20% of patients ED hyperglycemia would be recognized, communicated to patients, or they would receive ED treatment.

PATIENTS AND METHODS

Study Design

This was a retrospective cohort study using a structured medical record review of consecutive ED patients presenting between September 1, 2004 and August 31, 2005. We obtained our Institutional Review Board's approval with waiver of informed consent.

Study Setting and Population

The site of data collection was an urban, academic institution with approximately 50,000 annual ED visits. Care of hospitalized patients on the medical service is provided or supervised by staff hospitalists. Using the hospital's electronic records, we identified all patients with serum glucose ordered from the ED during the study time period. When there were multiple glucose results, we included only the first glucose values. Based on conservative thresholds for association of random glucose with poor clinical outcomes in hospitalized patients and with undiagnosed diabetes,[5,9] we considered glucose <140 mg/dL (7.8 mmol/L) as normal and categorized the remaining values into 2 groups: 140-199 mg/dL (7.8-11.0 mmol/L) and ≥200 mg/dL (11.1 mmol/L).

Study Protocol

We selected 200 patients from each glucose group using a random number generator, and 2 investigators (D.J.S., A.A.G.) performed a detailed chart review using a standardized data abstraction form. The research team met frequently to maintain consistency in data collection and to resolve disputes.

We recorded demographic data, presence of a primary care provider, relevant past medical history, current medications, ED treatment (insulin, oral hypoglycemic agents, and intravenous fluids), disposition (admission or discharge), and final diagnoses. Additionally, we evaluated capillary blood glucose values during the ED stay and serum glucose values during the ED and hospital stay to evaluate for hypoglycemia (defined as glucose <65 mg/dL). We also evaluate diagnosis codes to identify concurrent infection, sepsis, or trauma that may have been associated with the hyperglycemia, based on previously reported methodology.[10,11] Finally, we examined the inpatient or ED written discharge instructions to evaluate newly started antidiabetic medications, communication of hyperglycemia, and recommendation of repeat glucose/diabetes testing.

Data Analysis

We performed statistical analyses using Stata 9.0 (Stata Corp., College Station, TX) and summarized data using basic descriptive statistics with 95% confidence intervals (95%CIs). We measured interrater agreement for chart abstraction by calculating the kappa statistic for a 5% sample of charts abstracted by both investigators. We considered kappa >0.80 as high interrater agreement. We evaluated differences between subgroups of interest using chi square test. All P values are 2-tailed, with $P < 0.05$ considered statistically significant.

RESULTS

During the data collection period, 27,688 (58%) ED visits had at least 1 serum glucose result. After excluding multiple glucose results for the same visit, the median glucose value was 106 mg/dL (range, 7-2280 mg/dL); 3517 (13%) values were 140-199 mg/dL, and 2304 (8%) values were ≥200 mg/dL. We located 385 of the 400 (96%) randomly selected charts. Interrater agreement for chart review was high (kappa = 0.91-0.98).

Table 1 shows demographic characteristics and Table 2 shows clinical data of the sample, stratified by glucose group and charted diagnosis of diabetes. Overall, 55% of patients with glucose values 140-199 mg/dL and 16% of patients with glucose ≥200 mg/dL had no prior diabetes diagnosis. Hyperglycemia was associated with sepsis for 22% of patients, infection without sepsis for 13% of patients, and traumatic injury for 19% of patients.

No patient received intravenous fluids with dextrose prior to initial serum glucose determination, and there was no difference in home corticosteroid use between groups ($P = 0.23$). Patients with known diabetes were more likely to receive insulin in the ED ($P < 0.01$). Only 1 patient received an oral hypoglycemic agent in the ED. Three patients had documented hypoglycemia on capillary blood glucose during the ED stay, and no

TABLE 1
Demographic and Clinical Characteristics of 385 Patients with ED Hyperglycemia

	Glucose 140–199 mg/dL % (95%CI) or Median (IQR)		Glucose ≥200 mg/dL % (95%CI) or Median (IQR)		
Variable	**Diabetes (n = 87)**	**No Diabetes (n = 107)**	**Diabetes (n = 160)**	**No Diabetes (n = 31)**	**Total n (%) or Median (IQR) (n = 385)**
Demographics					
Age	66 (54–75)	68 (50–83)	63 (52–75)	58 (33–76)	64 (51–76)
Female sex	39% (29–50)	58% (48–67)	55% (47–63)	26% (12–45)	50% (45–55)
Race/ethnicity					
White	67% (56–76)	75% (65–83)	61% (53–69)	71% (52–86)	258 (67%)
Black	22% (14–32)	9% (5–17)	21% (15–28)	10% (2–26)	65 (17%)
Hispanic	2% (0–8)	4% (1–9)	6% (3–10)	3% (0–17)	26 (4%)
Other	9% (4–17)	12% (7–20)	12% (8–19)	16% (5–34)	46 (12%)
Insurance					
Private	32% (23–43)	41% (32–51)	32% (25–40)	45% (27–64)	137 (36%)
Medicare	61% (50–71)	47%(37–57)	49% (41–57)	32% (17–51)	192 (50%)
Medicaid	6% (2–13)	7% (3–14)	16% (10–22)	6% (1–21)	40 (10%)
None	1% (0–6)	5% (2–11)	3% (1–7)	16% (5–34)	16 (4%)
Assigned PCP	95% (89–99)	84% (76–90)	86% (80–91)	71% (52–86)	86% (83–90)
Past medical history					
Hypertension	61% (50–71)	45% (35–55)	58% (50–66)	39% (21–56)	206 (54%)
Hyperlipidemia	28% (19–38)	21% (13–29)	25% (19–32)	10% (2–26)	90 (23%)
Coronary artery disease	41% (31–52)	29% (21–38)	26% (20–34)	13% (4–30)	113 (29%)
Current medications					
Insulin	36% (26–47)	0	54% (46–62)	0	117 (30%)
Sulfonylurea	25% (17–36)	0	26% (19–33)	0	63 (16%)
Other oral hypoglycemic	39% (29–50)	0	24% (18–32)	0	73 (19%)
Systemic corticosteroids	5% (1–11)	10% (5–17)	4% (1–8)	6% (1–21)	23 (6%)

Abbreviations: CI, confidence interval; IQR, interquartile range; PCP, primary care physician.

TABLE 2
Management and Discharge Instructions for 385 Patients with ED Hyperglycemia

	Glucose 140–199 mg/dL % (95%CI) or Median (IQR)		Glucose ≥200 mg/dL % (95%CI) or Median (IQR)		
Variable	**Diabetes**	**No Diabetes**	**Diabetes**	**No Diabetes**	**Total n (%) or Median (IQR)**
ED clinical data	(n = 87)	(n = 107)	(n = 160)	(n = 31)	(n = 385)
Glucose value, mg/dL	167 (163–170)	160 (157–163)	308 (285–330)	272 (242–300)	231 (220–244)
Insulin	6% (2–13)	1% (0–3)	31% (24–39)	19% (7–37)	61 (16%)
IVF without dextrose*	44% (33–55)	54% (44–64)	51% (43–58)	68% (49–83)	198 (51%)
Hyperglycemia charted as diagnosis	3% (1–10)	0	18% (12–25)	16% (5–34)	36 (9%)
Hospital admission	76% (65–84)	79% (71–87)	73% (66–80)	84% (66–95)	293 (76%)
Discharge data†	(n = 84)	(n = 98)	(n = 156)	(n = 25)	(n = 363)
New insulin Rx	8% (3–16)	5% (2–12)	6% (3–10)	16% (5–36)	26 (7%)
New sulfonylurea Rx	2% (0–8)	1% (0–6)	4% (1–8)	0	10 (3%)
New other oral hypoglycemic Rx	1% (0–6)	1% (0–6)	3% (1–7)	8% (1–26)	9 (2%)
Any new diabetes Rx	12% (6–21)	7% (3–14)	12% (7–18)	24% (9–45)	42 (12%)
Hyperglycemia noted in written instructions	4% (1–10)	3% (1–9)	15% (10–21)	24% (9–45)	36 (10%)
Repeat glucose/diabetes testing charted	5% (1–12)	1% (0–6)	9% (5–15)	16% (5–36)	23 (6%)

Abbreviations: CI, confidence interval; ED, emergency department; IQR, interquartile range; IVF, intravenous fluids; Rx, prescription.

* No patients received oral or intravenous glucose prior to glucose determination.

† 22 discharge instructions missing (12 deaths during hospitalization, 10 missing instructions).

patients had hypoglycemia based on serum glucose during the ED or hospital stay. Among hospitalized patients, 61% had inpatient orders for diabetic-consistent/carbohydrate-consistent diet, 65% for capillary glucose tests daily, and 63% for sliding scale insulin.

We also present written discharge instructions data for 363 visits (253 inpatient and 110 ED) in Table 2; discharge instructions were not available for 22 visits (12 deaths during hospitalization, 10 missing instructions). New antidiabetic medications were prescribed for 42 (12%) patients, all from the inpatient setting. There was no difference between inpatient and ED communication of hyperglycemia (10% [95%CI, 7%-14%] versus 9% [95%CI, 4%-15%]) and recommendation for further outpatient testing (8% [95%CI, 4%-11%] versus 4% [95%CI, 0%-7%]) in written discharge instructions ($P = 0.73$ and 0.16, respectively). Compared to those with glucose 140-199 mg/dL, patients with glucose $\geq$200 mg/dL were more likely to receive written communication of hyperglycemia (17% [95%CI, 11%-22%] versus 3% [95%CI, 0%-6%]) and recommendation for further outpatient testing (10% [95%CI, 6%-14%] versus 3% [95%CI, 0%-5%] (both, $P < 0.01$).

DISCUSSION

Although noncritical ED glucose values may be overlooked, values sufficient to motivate inpatient and long-term management are sometimes uncovered, and when unrecognized may be missed opportunities. Indeed, admission hyperglycemia has been linked to poor clinical outcomes in hospitalized patients for a variety of conditions, particularly for myocardial infarction, stroke, and critical illness.[12–15]

In this study, we evaluated recognition, communication, and management of ED glucose values above a relatively conservative threshold of 140 mg/dL, occurring in 21% of ED glucose results. Diabetes screening thresholds for casual glucose values as low as 120 mg/dL,[9] and intensive glycemic control in critically ill patients to a target as low as 110 mg/dL have been suggested.[5] Nevertheless, only 16% of our sample received insulin in the ED for hyperglycemia, and hyperglycemia was charted as a diagnosis in only 9% of cases.

This is especially important because 77% of ED visits without hyperglycemia charted as a diagnosis resulted in hospitalization, and early glycemic control was infrequently initiated. Limited ED management of hyperglycemia may be driven by the presence of more critical management issues (eg, 54% of patients had concomitant infection or trauma), lack of familiarity with guidelines, which suggest treatment to glucose <140 mg/dL in critically ill patients and <180 mg/dL in all hospitalized patients,[16] or fear of adverse events, such as hypoglycemia. Additionally, ED crowding has been shown to effect decreased quality and timeliness of treatment for pneumonia, and may have similar effects for hyperglycemia.[17] Inpatient recognition of hyperglycemia, based on orders for diet, glucose checks, and insulin, appeared significantly better, but this did not translate to improved communication in written discharge instructions. Additionally, many hospitalized patients may spend many hours, or even days, in the ED waiting for beds, which currently is a missed opportunity to initiate early therapy.

Written discharge instructions informed less than 10% of patients of their hyperglycemia or outlined a plan for further evaluation and management. Our prior work suggests that nearly all (95%) ED patients want to be informed of elevated blood glucose and are willing to follow-up, if instructed.[18] The current data suggests that hyperglycemia in ED and hospitalized patients is frequently unrecognized and undertreated, and opportunities to institute an outpatient plan to address hyperglycemia are frequently missed.

This study has several potential limitations. This study was performed at a single academic center, which limits generalizability to other geographic areas and hospital types. Accuracy of abstracted data depended on chart review, which is limited by the possibility of missing, incomplete, or unreliable information. Standardized definitions and abstraction forms limited potential for bias, and high interrater agreement demonstrated internal reliability of the chart review. We considered only initial glucose values and were unable to determine nutritional status; it is possible that subsequent measurements were within an acceptable range. Conversely, hospitalized patients may have developed hyperglycemia subsequent to the initial glucose result, which would underestimate the scope of inpatient hyperglycemia. Also, because there are limited data for interpretation of ED hyperglycemia, we were unable to determine optimal glucose thresholds. Finally, we were unable to

evaluate the content of verbal instructions or letters to outpatient providers, which limited our ability to fully describe communication of abnormal findings. However, patients do not often retain information in verbal instructions, in the context of new diagnoses and complex medical regimens.

In summary, recognition, management, and communication of ED hyperglycemia were suboptimal in our patient population and represent a missed opportunity. Enhanced recognition, management, and referral for hyperglycemia observed during usual ED care may provide an unobtrusive method to improve identification of undiagnosed diabetes/prediabetes and initiation of intensive glycemic control for hospitalized patients.

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