

# Diabetes Care in Hospitalized Noncritically Ill Patients: More Evidence for Clinical Inertia and Negative Therapeutic Momentum

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**BACKGROUND:** Little is known about management of hyperglycemia in inpatients.  
**OBJECTIVE:** To gain insight into caring for hospitalized patients with hyperglycemia.

**DESIGN:** Retrospective analysis.

**SETTING:** Teaching hospital.

**PATIENTS:** Data on all patients discharged between January 1, 2001, and December 31, 2004 with a diagnosis of diabetes or hyperglycemia were extracted and linked to laboratory and pharmacy databases. Only the data on patients who did not require intensive care and who were hospitalized for at least 3 days were analyzed.

**MEASUREMENTS:** Average bedside glucose during the first and last 24 hours of hospital stay and for the entire length of stay; assessment of changes in insulin regimen and dose.

**RESULTS:** The average age of patients included in the study (n = 2916) was 69 years. Fifty-seven percent of the patients were men, 90% were white, and average length of stay was 5.7 days. More than 20% of the patients had evidence of sustained hyperglycemia. Forty-two percent of the patients who showed poor control of glycemia (glucose > 200 mg/dL) during the first 24 hours were discharged in poor control. The frequency of hypoglycemia was low (only 2.2 of 100 measurements per person) compared with hyperglycemia (25.5 of 100 measurements per person). Most patients (72%) received insulin during hospitalization, but there was high use of short-acting insulin and less than optimal intensification of therapy (clinical inertia); many patients had insulin therapy decreased despite persistent hyperglycemia (negative therapeutic momentum).

**CONCLUSIONS:** Glycemic control in the hospital was frequently poor, and there was suboptimal use of insulin, even among patients with sustained hyperglycemia. Educational programs directed at practitioners should focus on the importance of inpatient glucose control and provide guidelines on how and when to change therapy. *Journal of Hospital Medicine* 2007;2:203–211. © 2007 Society of Hospital Medicine.

**KEYWORDS:** diabetes mellitus, hospitalization; hyperglycemia.

**D** diabetes confers a substantial burden on the hospital system. Diabetes is the fourth-leading comorbid condition associated with any hospital discharge in the United States<sup>1</sup>. During 2001, for more than 500,000 patients discharged from U.S. hospitals diabetes was listed as the principal diagnosis and for more than 4 million it was listed as a codiagnosis.<sup>2,3</sup> Nearly one-third of diabetes patients require at least 2 hospitalizations annually,<sup>4</sup> and inpatient stays account for the largest proportion of direct medical expenses incurred by persons with the disease.<sup>5</sup>

Numerous studies have demonstrated that hyperglycemia is

associated with adverse outcomes of hospitalized patients.<sup>6–8</sup> However, studies have also confirmed that attention to lowering glucose levels in the hospital improves patient outcomes.<sup>7,8</sup> Although inpatients with known diabetes will likely constitute the largest and most visible percentage of those who will require treatment for high glucose, the recommendation to control glucose applies to all inpatients regardless of whether they have been diagnosed with diabetes prior to hospitalization or have manifested hyperglycemia only during the hospital stay.<sup>7–9</sup>

Now that the relationship between hyperglycemia and hospital outcomes is well established, the task of organizations that deliver care and set policy is to translate current recommendations of good glucose control into real-world hospital settings. Quality improvement organizations are currently working toward developing and disseminating performance measures for control of inpatient hyperglycemia.<sup>10,11</sup> Although management of hospital hyperglycemia is often perceived as suboptimal,<sup>12</sup> actual data are limited and are based on review of small numbers of charts,<sup>13–15</sup> and information is even sparser on the pharmacologic strategies being used to treat inpatient hyperglycemia. Before educational programs and policies can be developed, individual hospital systems need to gain more insight into how hyperglycemia is being managed in the hospital.

We reported previously the results of a review of a small number of charts ( $n = 90$ ) of patients hospitalized with diabetes. The findings from this review suggested there was clinical inertia in glycemia management in the hospital.<sup>15</sup> Clinical inertia was originally described in relationship to diabetes care in the outpatient setting and was defined as a failure to perform a needed service or make a change in treatment when indicated.<sup>16,17</sup> Since the original description, additional reports have documented the problem of clinical inertia, but these have all been based on experiences in the outpatient setting.<sup>18–22</sup> To our knowledge, our previous report was the first to question whether clinical inertia occurred in the hospital environment. In addition, we described the “negative therapeutic momentum”—a deintensification of treatment despite ongoing hyperglycemia<sup>15</sup>. However, our prior study examined only a small number of cases and did not include detailed data on pharmacologic treatment for hyperglycemia. Therefore, we expanded our analysis using an information systems–

rather than a chart review–based methodology to assess the status of hyperglycemia management in our hospital.

## METHODS

### Setting

Our tertiary-care academic teaching hospital is a 200-bed facility in metropolitan Phoenix, Arizona. All adult general medical and surgical specialties are represented, including transplantation services; the hospital also has a level 2 trauma center and an inpatient rehabilitation unit. Care is provided by various types of practitioners, including postgraduate trainees, faculty, physician assistants, and nurse-practitioners. An electronic medical record links outpatient and inpatient records with laboratory results and pharmacy orders. The core electronic health record system is the Centricity/Last-Word platform, provided by GE/IDX. The ancillary core systems, including laboratory and pharmacy, are interfaced with the Centricity system and maintained by on-site Mayo Clinic information technology professionals.

### Case Selection

Patients discharged with an *International Classification of Diseases, 9th Revision, Clinical Modification* (ICD-9-CM) diagnosis code for diabetes (ICD-9-CM code 250.xx) or hyperglycemia (ICD-9-CM code 790.6) were identified in a search of the hospital’s electronic billing records.<sup>2–4</sup> Our facility does not provide obstetric or pediatric services; therefore, corresponding ICD-9-CM codes for those populations were not included. Both primary and non-primary diagnostic fields were searched. Discharges were extracted for the period between January 1, 2001, and December 31, 2004. Data retrieved included patient age, ethnicity/race, length of stay (LOS), and type of hospital service with primary responsibility for the patient’s care. For confidentiality reasons, individual patients were not identified, and the unit of analysis was the discharge.

Our analyses focused principally on the non-critically ill, defined as those patients who did not require a stay in our intensive or intermediate care units; critically ill patients were identified based on room location in the data set and excluded. The reasons this study assessed hyperglycemia management in the noncritically ill were 2-fold. First, the critically ill may migrate in and out of intensive care depending on their health status and thus experience different intensities of glucose management.

Second, in our facility the therapeutic approach to hyperglycemia management is different for the critically ill than for the noncritically ill; the critically ill may receive intravenous and/or subcutaneous insulin, whereas subcutaneous insulin therapy only is given to the noncritically ill. Thus, the noncritically ill represent a more clearly defined patient population whose therapies would be easier to evaluate. We also restricted the final analysis to patients who had a LOS of 3 days or less, so that differences in glucose control and insulin therapy between the first and last 24 hours of hospital stay could be assessed.

Data on 30 randomly chosen patients from different years was extracted from electronic records. A spreadsheet of the data was compared against data in our online electronic medical records. The online data were printed, and packets were made of the data for each patient selected for review. The patient demographic information was validated against our registration screen. Inpatient stay was validated to verify a patient was in intensive or intermediate care. The result of each glucose test performed while the patient was in the hospital was printed and the calculations validated. The insulin given while the patient was hospitalized was also printed and reviewed to verify the type of insulin and calculations for the amounts of insulin given.

### Assessment of Glycemic Control

After extraction of hospital cases, data were linked via patient identifiers to our electronic laboratory database to retrieve information on glucose values. Glucose data included both blood and bedside measurements. In our institution, bedside glucose monitoring is performed with an instrument that scans and records patient identification, followed by direct downloading to our laboratory database. Commercial software (Medical Automation Systems, Charlottesville, VA) facilitates the interfacing of glucometer data with the electronic laboratory file.

Nearly all hospitalized patients had either bedside glucose (84%) or blood glucose (86%) data available for analysis. However, the mean number of bedside glucose measurements was 3.4 per day, whereas the average number of blood glucose measurements was only 1.0 per day. Because of the greater number of bedside measurements and because practitioners typically make therapeutic decisions about hyperglycemia management on the basis of daily bedside glucose results, these values

were used to assess glycemic control of patients in the hospital discharge data.<sup>15</sup>

To assess glycemic control, we used methods similar to those previously published by ourselves and others.<sup>15,23</sup> We averaged each patient's available bedside glucose measurements to determine the composite average (BedGluc<sub>avg</sub>). We also computed the average of bedside glucose measurements obtained during the first 24 hours after admission (F24BedGluc<sub>avg</sub>) and during the last 24 hours before discharge (L24BedGluc<sub>avg</sub>), then examined the distributions of BedGluc<sub>avg</sub>, F24BedGluc<sub>avg</sub>, and L24BedGluc<sub>avg</sub>. The first 24-hour period was calculated forward from the recorded time of admission, and the last 24-hour period was calculated backward from the time of discharge. We calculated the frequency that each patient's bedside measurements showed hypoglycemia (bedside glucose < 70, < 60, < 50, or < 40 mg/dL) and showed hyperglycemia (bedside glucose > 200, > 250, > 300, > 350, or > 400 mg/dL). Results were recorded as the number of values per 100 measurements per person; this method allowed adjustment for variation in the individual number of measurements and captured information on multiple episodes of hypo- or hyperglycemia of individual patients.<sup>15,23</sup>

### Hyperglycemia Therapy

Links to our inpatient pharmacy database enabled determination of types of pharmacotherapy actually administered to patients to treat hyperglycemia. Our electronic pharmacy records are designed so that intravenous medications (eg, intravenous insulin), scheduled oral and subcutaneous medications (eg, subcutaneous insulin), and medications administered on a one-time or as-needed basis (eg, sliding-scale insulin) are documented electronically as separate categories. In our facility, intravenous insulin is administered only in the intensive care setting or as a component of total parenteral nutrition, and we excluded intravenous insulin use from this data. Thus, our analysis of insulin therapy focused only on elucidating patterns of subcutaneous treatment.

We classified hyperglycemia treatment as "no therapy," "oral agents only," "oral agents plus insulin," and "insulin only." Patients were regarded as having received an oral agent or insulin if they were administered the medication at any time during their inpatient stay. For management of hyperglycemia in noncritically ill patients, the use of a pro-

grammed basal-bolus insulin program is advocated rather than the use of only a short-acting bolus or “sliding-scale” regimen.<sup>7,8</sup> Therefore, we further examined the insulin treatment strategies by classifying the type of regimen as “basal only” (if only an extended-release preparation was used), as “basal bolus” (if the therapy consisted of a long-acting plus a short-acting formulation), or as “bolus only” (if the only insulin administered was a short-acting preparation).

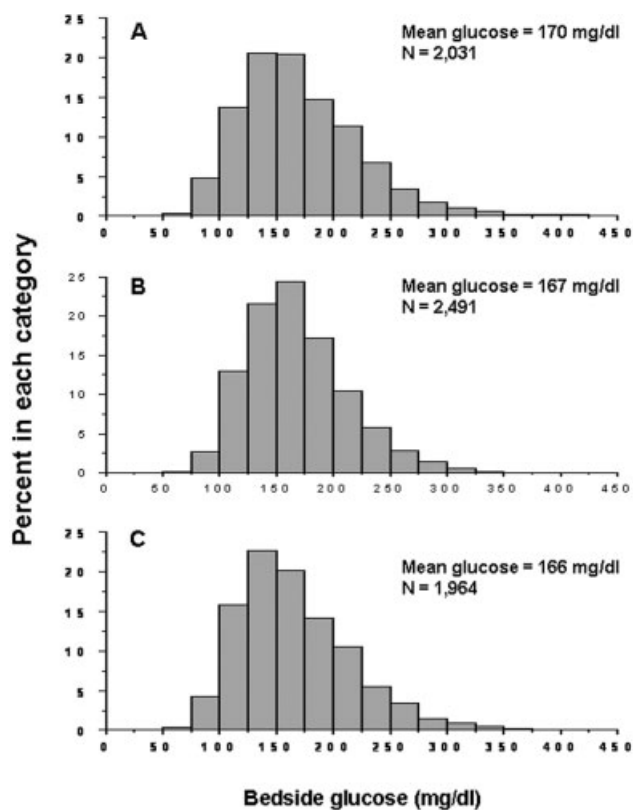
In addition to characterizing the general therapeutic approaches to hyperglycemia, we determined changes in the amount of insulin administered according to the severity of the hyperglycemia. Among patients who received insulin, we compared the average total units of insulin used during the last 24 hours before discharge with the amount administered during the first 24 hours of hospitalization. If more units were used during the last 24 hours than in the first 24 hours, the amount of insulin administered was categorized as having increased; if fewer units were provided during the last 24 hours, then the insulin amount was classified as having decreased; otherwise, no change was considered to have occurred. The BedGluc<sub>avg</sub> values were divided into 3 intervals using tertile cut points, and the differences in the proportion of patients by each type of insulin treatment regimen and the categories of insulin change were compared across tertiles; differences in proportions were determined using the  $\chi^2$  statistic.

## RESULTS

### Patient Characteristics

Between January 1, 2001, and December 31, 2004, a total of 7361 patients were discharged from our facility with either a diabetes or a hyperglycemia diagnosis (16% of all discharges); the percentage of discharges associated with these diagnoses increased from 14.9% in 2001 to 16.4% in 2004. Most patients with diabetes or hyperglycemia (5198 or 71%) received care outside the intensive- or intermediate-care setting.

Among the noncritically ill patients whose LOS was at least 3 days ( $N = 2916$ ), average age was 69 years, and average LOS was 5.7 days. Most of the discharged patients were men (57%), and 90% were white. Most patients were discharged from primary care (45%; general internal medicine or family medicine) or surgical services (34%), with the rest discharged from other specialties (eg, cardiology, transplant medicine). Compared to the noncritically ill, who had an LOS of at least 3 days, those

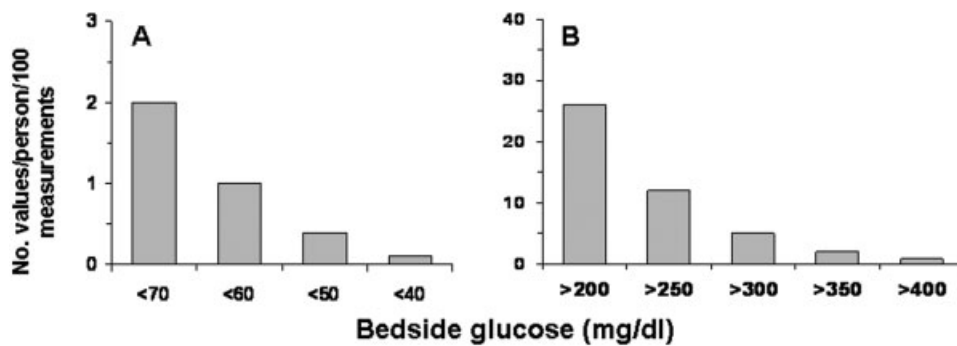


**FIGURE 1.** Distributions of average bedside glucose values (mg/dL) for (A) the first 24 hours of hospitalization (F24BedGluc<sub>avg</sub>), (B) entire length of stay (BedGluc<sub>avg</sub>), and (C) last 24 hours of hospitalization (L24BedGluc<sub>avg</sub>).

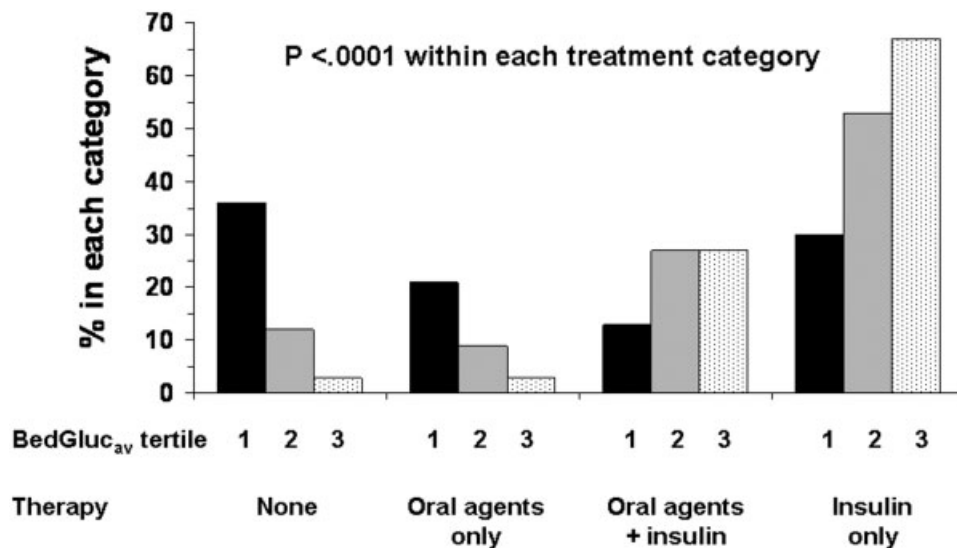
noncritically patients whose LOS was less than 3 days ( $n = 2282$ ) were slightly younger (mean age 68 versus 69 years,  $P < .001$  by Mann-Whitney testing) but were comparable in sex and race distribution ( $P > .07$  for both by chi-square testing).

### Glycemic Control

The median duration between admission and time of first bedside glucose measurement was 3.0 hours. Patients had an average of 19 bedside glucose measurements; the overall mean number of bedside measurements was 3.4 per day, 3.7 during the first 24-hour period, and 3.4 during the last 24 hours of hospitalization. Nearly 25% of patients were hyperglycemic (bedside glucose  $> 200$  mg/dL) during the first 24 hours of hospitalization (Fig. 1A), 20% had persistent hyperglycemia throughout the entire hospitalization (Fig. 1B), and 21% were hyperglycemic during the 24 hours before discharge (Fig. 1C), with some patients discharged with an average bedside glucose of at least 300 mg/dL during the 24 hours before discharge.



**FIGURE 2.** (A) Hypoglycemic measurement was less frequent than (B) hyperglycemic measurement.



**FIGURE 3.** Distribution of therapies by tertile of  $BedGluc_{avg}$ : tertile 1 = 129 mg/dL, tertile 2 = 165 mg/dL, and tertile 3 = 219 mg/dL.

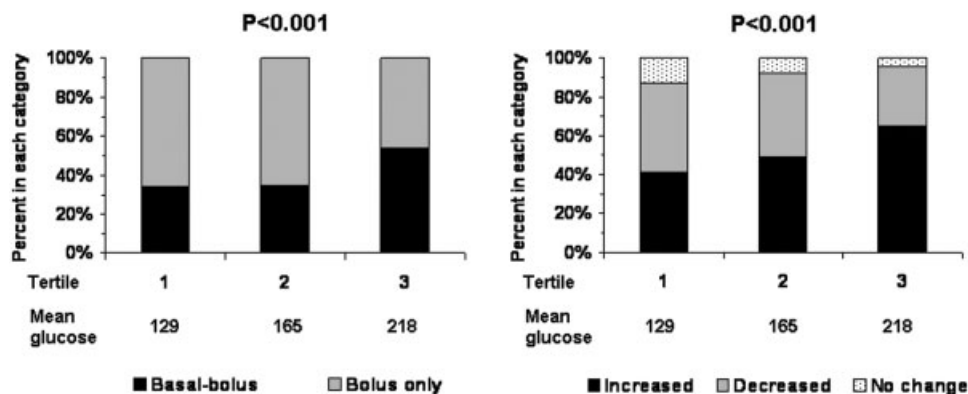
The incidence of hypoglycemic episodes was lower than that of hyperglycemic episodes: 21% of patients had at least 1 bedside glucose value less than 70 mg/dL, but 68% had at least 1 value greater than 200 mg/dL. The frequency of hypoglycemic measurements was low (Fig. 2A) compared with the frequency of hyperglycemic episodes (Fig. 2B).

### Hyperglycemia Therapy

Most patients (72%) received subcutaneous insulin at some point during their hospital stay; 19% had “no therapy,” 9% had “oral agents only,” 26% had “oral agents plus insulin,” and 46% had “insulin only.” The proportion receiving “no therapy” decreased from 32% among patients whose  $BedGluc_{avg}$  was in the first tertile to 2% in the third tertile; the percentage of patients taking “oral agents only” decreased from 18% to 1%; the

proportion taking “oral agents plus insulin” was 17% in the first tertile and 30% in the third; and the proportion of those taking “insulin only” was 32% in the first tertile and 66% in the third (Fig. 3). Thus, nearly all patients whose  $BedGluc_{avg}$  value was in the third tertile received insulin, either as monotherapy or in combination with oral agents.

Among insulin users, 58% received bolus-only, 42% received basal-bolus, and 1% received basal-only injections. Because of the small proportion of basal-only patients, we conducted analyses only of patients whose insulin treatment fell into 1 of the first 2 categories. The use of a basal-bolus insulin program increased from 34% in patients whose  $BedGluc_{avg}$  was in the first tertile to 54% for those who had  $BedGluc_{avg}$  in the third tertile ( $P < .001$ ; Fig. 4, left). Thus, although there was a greater



**FIGURE 4.** Changes in insulin regimen (left,  $N = 2084$ ) and in the amount of insulin administered (right,  $N = 1680$ ) by tertile of mean overall bedside glucose ( $\text{BedGluc}_{\text{avg}}$ ).

transition to a more intensive insulin regimen with worsening hyperglycemia, a substantial number of patients (46%) whose  $\text{BedGluc}_{\text{avg}}$  was in the third tertile still did not have their insulin regimen intensified to a basal-bolus program.

Fifty-four percent of subcutaneous insulin users ( $N = 1680$ ) had an increase in the amount of insulin administered between the first and last 24 hours of hospitalization (average increase, 17 U), 39% had a decrease (average decrease, 12 U), and 7% had no change. With rising hyperglycemia, more patients had their insulin increased by the time of discharge; 41% of persons who had  $\text{BedGluc}_{\text{avg}}$  values in the first tertile were on more insulin by the time of discharge, whereas 65% of those who had average glucose values in the third tertile had insulin increased (Fig. 4, right). However, the pattern of changes in the amount of administered insulin was heterogeneous, with increases, decreases, and no change occurring in all tertiles of  $\text{BedGluc}_{\text{avg}}$  (Fig. 3, right). Nearly 31% of patients whose  $\text{BedGluc}_{\text{avg}}$  values were in the third tertile actually had a decrease in insulin. This decrease occurred despite evidence of a low frequency of hypoglycemia (only 1.2 values  $< 70$  mg/dL per 100 measurements per person) and a high frequency of hyperglycemia (55.4 values  $> 200$  mg/dL per person per 100 measurements).

## DISCUSSION

The number of diabetes-associated hospital discharges has been climbing<sup>2,3</sup>; our own data indicate an increase in the number of patients with diabetes as a proportion of the total number of discharged patients. A recent consensus advocates good glu-

cose control in the hospital to optimize outcomes,<sup>7-9</sup> and institutions need to begin the process of assessing their quality of inpatient hyperglycemia management as a first step to enhancing care.

There are no guidelines about which method of glucose measurement (ie, blood glucose or bedside glucose) should be used as the quality measure to evaluate glycemic control in hospital patients. Both blood and bedside glucose measurements have been used in outcomes studies.<sup>23,24</sup> We analyzed capillary bedside values measured by a method subjected to ongoing quality control oversight and stored in the electronic laboratory database. Bedside glucose measurements are typically obtained with far greater frequency than blood glucose measurements and therefore provide better insight into daily changes in glycemic control; in practice, clinicians rely on bedside values when assessing hyperglycemia and making therapeutic decisions.

There is also no consensus about what glucose metric should be used to assess the status of glycemic control in the hospital. Some studies have used single glucose values to examine the relationship between hyperglycemia and outcomes,<sup>25,26</sup> whereas others have used values averaged over various lengths of time.<sup>24,27</sup> To evaluate glucose control, we averaged capillary measurements in the first 24 hours of hospitalization ( $\text{F24BedGluc}_{\text{avg}}$ ), the last 24 hours of hospitalization ( $\text{L24BedGluc}_{\text{avg}}$ ), and for the entire LOS ( $\text{BedGluc}_{\text{avg}}$ ), and we calculated the number of documented hyper- and hypoglycemic events. The measures we used to examine hyperglycemia would serve as useful benchmarks for following the progress of future institutional

interventions directed at glucose control in hospitalized patients at our hospital.

A substantial number of our patients selected for analysis (ie, noncritically ill with LOS  $\geq$  3 days) were found to have sustained hyperglycemia at the beginning, during, and at the end of their hospital stay. We found very few instances of severe hypoglycemia (values  $<$  50 or  $<$  40 mg/dL), and the low frequency of hypoglycemia compared to that of hyperglycemia could encourage practitioners to be more aggressive in treating hyperglycemia. The high frequency of recorded bedside glucose compared with blood glucose measurements ( $\geq$  3 per day), the ongoing patient surveillance by medical, nursing, and other staff members, and our institution's written hypoglycemia policy most likely minimize the number of unobserved, undocumented, or untreated hypoglycemic episodes. There are no data or recommendations about what would be an acceptable number of hypoglycemic episodes in the hospital.

Very little is known about the therapeutic strategies being applied to hyperglycemia in the hospital. Our data show that subcutaneous insulin (either alone or in combination with oral agents) was used at some point during hospitalization for nearly three-fourths of noncritically patients who were in the hospital for 3 days or longer. Moreover, as hyperglycemia worsened, use of oral hypoglycemic agents declined, there was a shift toward greater use of a scheduled basal-bolus insulin program, and a greater proportion of patients had more insulin administered.

Although these latter findings are encouraging and suggest that practitioners are responding to the severity of hyperglycemia, further examination of the data suggests that a substantial number of patients in the highest glucose tertile did not have insulin therapy intensified. Nearly half our patients whose glucose values were in the highest tertile were treated with short-acting insulin alone—probably an ineffective regimen<sup>23,28</sup>—or did not have more insulin administered. The higher doses administered were not likely solely a result of using more “sliding-scale” insulin, as previous investigators actually found no correlation between intensity of the sliding scale and total daily insulin dose.<sup>14</sup> Although evidence here is circumstantial (we did not examine changes in provider orders in response to glucose levels), these findings, together with those in our previous study<sup>15</sup> and in another

study,<sup>14</sup> provide indirect evidence of clinical inertia in the hospital.

Beyond clinical inertia, however, there was evidence of “negative therapeutic momentum”: nearly one-third of patients whose glucose was in the highest tertile had insulin decreased rather than increased, despite the low frequency of hypoglycemia and the high frequency of hyperglycemia. It is likely that even a single episode of hypoglycemia concerned practitioners, but the clinical response in these situations should be to investigate and correct the circumstances leading to the hypoglycemia, rather than to necessarily deintensify therapy in the face of continued hyperglycemia. The analysis of this larger data set corroborated our observations of clinical inertia and negative therapeutic momentum from an earlier study of chart reviews of a smaller patient sample.<sup>15</sup>

The variable application of insulin therapy to the treatment of hyperglycemia may be an indication of the level of comfort practitioners have about using this pharmacologic agent. A recently completed survey of resident physicians at our institution indicated that understanding how to use insulin was the most common barrier to successful management of inpatient hyperglycemia.<sup>29</sup> These observations reinforce the need for institutions to develop standardized insulin order sets and develop programs to educate the staff on the use of insulin.

This study differs from our original analysis based on chart review in 4 ways. First, the sample size in our first study ( $n = 90$ ) was small and derived from discharges from a single year (2003), whereas the sample in the present study spanned several years and included several thousand cases. Second, in our prior study we did not have detailed pharmacologic data on glucose management and how treatment approaches varied relative to severity of hyperglycemia. In general, there is very limited data on what therapeutic strategies are being applied to inpatient hyperglycemia, and this analysis of a large sample of cases provides more insight into how practitioners are managing glucose.

Third, we wanted to corroborate observations made in our previous report using a different methodology—in this instance, adapting existing information systems to assessment of inpatient diabetes care. For example, our last study was based on a limited number of glucose observations but suggested that the prevalence of hypoglycemia in our hospital was low compared with that of hypergly-

emia; the present analysis of a very large number of glucose values confirmed these initial findings. In addition, use of information systems versus a chart review approach to assessing inpatient diabetes care corroborates our earlier suspicions about the presence of clinical inertia and negative therapeutic momentum in glucose management.

Fourth and finally, this study gave us experience with use of electronic records as a means to assess the status of inpatient diabetes care. Electronic data sources will likely be common tools to monitor quality of inpatient diabetes care and will likely figure prominently in future accreditation processes.<sup>10,11</sup> Unlike chart abstraction, which would require extensive man-hours to extract data on few patients, use of electronic records allows examination of large numbers of hospital cases. Queries of information systems could be automated, and report cards potentially generated and feedback given to providers on the status of inpatient glycemic control. The industry is actively pursuing software development to assist hospitals in assessing the quality of inpatient glycemic control (eg, RALS-TGCM, available at <http://www.medicalautomation.com/RALS-TGCM.html>).

However, there are also limitations to using electronic records as the sole method of assessing inpatient diabetes care. For instance, retrospective review of electronic records does not allow assessment of reasons underlying decision-making behavior of clinicians (eg, why they did or did not change therapy). Diabetes and hyperglycemia associated hospitalizations must be identified by discharge diagnosis codes, so some cases of diabetes and hyperglycemia were likely missed.<sup>30,31</sup> Recent guidelines propose preprandial targets for glucose in the hospital.<sup>8</sup> It is not easy to determine from an electronic data source which is a preprandial bedside glucose and which is a postprandial bedside glucose. Pre- and postprandial glucose categories would be difficult to define even during prospective studies, given the varying nature of nutritional support (ie, enteral, parenteral) used in the hospital and the administration of continuous dextrose infusions. Some type of quality control, such as conducting reviews of small samples of randomly selected charts to see how they compare with the electronic data, will need to be conducted.

From electronic discharge data, we cannot establish who had preexisting diabetes, who was admitted with new-onset diabetes, and who developed hyperglycemia as a result of the hospital stay. Our previous

random chart review<sup>15</sup> indicated it is likely that most (more than 90%) had an established diagnosis of diabetes before admission. However, the recommendation to treat hyperglycemia should apply to all patients regardless of whether they had diagnosed diabetes prior to hospitalization or manifested hyperglycemia only during the hospital stay.<sup>7-9</sup>

As hospitals move toward making efforts to improve performance related to treating inpatient hyperglycemia, they must be cognizant of the heterogeneity of the inpatient population and the challenges to managing hospital hyperglycemia before drawing conclusions about their management. Inpatients with hyperglycemia are a diverse group, comprising patients with preexisting diabetes, with previously undiagnosed diabetes, and stress-caused hyperglycemia. The unpredictable timing of procedures, various and changing forms of nutritional support, and different levels of staff expertise all contribute to the challenges of managing inpatient hyperglycemia. Inpatient practitioners may be forced to attempt glycemic control catch-up for hospitalized persons who had poor outpatient glucose control. Patients who have required a stay in the intensive care unit may have very different glycemic outcomes than those who have not. Patients whose LOS was short (< 3 days) may have different glycemic outcomes than persons whose LOS was longer ( $\geq 3$  days as defined here) because of the length of time practitioners have to work to control their hyperglycemia. These and other variables may have to be taken into account when developing and assessing the impact of interventions.

Despite these limitations, our analysis was helpful in providing direction for enhancing the care of hospitalized patients with hyperglycemia in our facility. For instance, our generalists and surgeons are the principal caretakers of noncritically ill patients with diabetes, and these practitioners could be targeted for the first continuing educational programs about inpatient care of hyperglycemia. In addition, institutional guidelines on when and how to initiate and change therapy—particularly insulin—can be designed so that hyperglycemia in noncritically ill hospital patients can be managed more effectively. These and other ongoing educational initiatives are necessary to ensure delivery of the highest quality of inpatient glucose care.

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