

# Insulin Therapy for Inpatients With Diabetes: Perceptions of Resident Physicians From Disparate Geographic Training Programs

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## ABSTRACT

**Background:** Improving diabetes management in hospitalized patients will require educational efforts for all practitioners, particularly resident physicians. Thus, a better understanding of residents' beliefs about diabetes in the hospital must be obtained.

**Objective:** The purpose of this article was to compare and contrast perceptions of resident physicians from 2 geographically distinct training programs regarding management of inpatients with diabetes.

**Methods:** Residents from training programs in the southwestern and southeastern United States were surveyed in 2006 and 2007 about their views on the importance of inpatient glucose control, their perceptions about desirable target glucose ranges, and the problems they encountered when trying to manage hyperglycemia in hospitalized patients.

**Results:** Responses were obtained from 52 of 66 residents at site 1 and from 65 of 85 residents at site 2 (N = 117 total respondents; total response, 77%; mean age, 31 years; 48% men; 61% primary care). Combined analyses revealed that respondents believed that glucose control was "very important" in critically ill patients (96%), perioperative patients (82%), and noncritically ill patients (66%). Most residents indicated that they would target a therapeutic glucose range within published recommendations. Less than half felt "very comfortable" managing inpatient hyperglycemia, hypoglycemia, subcutaneous insulin, or insulin drips. Respondents were not very familiar with existing institutional policies or preprinted order sets for insulin therapy. The most commonly reported barrier to management of inpatient hyperglycemia was lack of knowledge about appropriate insulin regimens and their use.

**Conclusions:** Trainees from 2 very different educational programs shared common beliefs, knowledge deficits, and perceived barriers about inpatient glucose management. Our findings indicate that trainees were uncertain about how to use insulin therapy in the hospital. Future inpatient diabetes quality-improvement efforts should focus on development of uniform educational programs targeting the management of inpatient diabetes, particularly as it relates to insulin use. (*Insulin*. 2009;4:106–113) © 2009 Excerpta Medica Inc.

**Key words:** diabetes mellitus, hyperglycemia, hospitalization, inpatient, practitioner beliefs.

## INTRODUCTION

Diabetes is one of the most common conditions encountered in the hospital,<sup>1</sup> and hospitalizations associated with diabetes have increased during the past decade.<sup>2,3</sup> Inpatient stays account for the largest proportion of direct medical expenses incurred by persons with the disease.<sup>4</sup> With the increased appreciation of the link between hospital hyperglycemia and adverse patient outcomes, more aggressive efforts to control inpatient glucose levels are being emphasized.<sup>5–7</sup>

Diabetes continues to be overlooked frequently in the hospital, and appropriate therapeutic responses to hyperglycemia frequently do not occur.<sup>8–10</sup> The perception exists that the state of diabetes care in the hospital is one of "glycemic chaos."<sup>11</sup> Despite the efforts of national, regional, and professional organizations<sup>6,7,12–16</sup> to develop and disseminate guidelines related to the management of inpatient hyperglycemia, ongoing concern exists about the slow pace at which hospitals are implementing recommendations about glycemic control.<sup>7</sup>

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Improving management of inpatient diabetes—creating glycemic order out of glycemic chaos—in the hospital will require intensive, coordinated, prolonged, and broad-based educational efforts directed at all types of health care practitioners. An important target of educational programs about diabetes care in the hospital will be resident physicians, who may care for up to 50% of hospitalized patients with diabetes in academic medical centers.<sup>8</sup> Educational sessions on the management of inpatient diabetes can be incorporated into preexisting training programs. Thus, a better understanding of residents' beliefs about diabetes in the hospital must be obtained before these educational programs are developed. In this analysis, we compare and contrast data on the beliefs of resident physicians about inpatient diabetes obtained in 2 distinct geographic facilities.

## METHODS

### Description of the Survey

This was a comparative analysis of previously published survey data obtained from 2 different academic institutions. A survey was developed in 2006 to evaluate perceptions of practitioners about inpatient glucose management.<sup>17,18</sup> The survey asked respondents about the importance of glucose control in the hospital, glucose targets thought to be optimal, and barriers encountered in the successful treatment of hyperglycemia. In addition, the questionnaire was designed to gather information about respondents' perceptions concerning the proportion of patients with diabetes in their inpatient practices, whether they believed that they were achieving their inpatient glucose targets, their degree of comfort with managing hyperglycemia and using insulin therapy, and their familiarity with existing institutional policies and preprinted insulin order sets.<sup>17,18</sup> Institutional review board (IRB) exemption was granted by the Mayo Clinic IRB, and approval was granted by the Atlanta Medical Center IRB. The survey, along with details regarding its development and piloting, was published elsewhere.<sup>17</sup> Responses to the survey were anonymous, although we did collect data on the training program to which the resident belonged.

### Description of the Hospitals

The survey was conducted in 2 separate teaching hospitals (site 1 and site 2). The survey was first used to assess beliefs among resident physicians at site 1<sup>17</sup> and then among midlevel practitioners at the same facility.<sup>18</sup> Site 1 (Mayo Clinic Arizona) is a 200-bed academic teaching hospital located in metropolitan Phoenix, Arizona. The inpatient diabetes population at site 1 is primarily white. The surveys

of the resident physicians at site 1 were conducted during January and February 2006. Site 2 (Atlanta Medical Center) is a 460-bed community teaching hospital located in downtown Atlanta, Georgia. The inpatient diabetes population at site 2 is mostly minority (45% African American, 37% white, 12% Hispanic, and 6% other races). Surveys were conducted among resident physicians at site 2 during March and April 2007.<sup>19</sup> Both sites have a history of quality-improvement initiatives directed at trying to better understand and improve their management of inpatients with diabetes.<sup>8,10,20,21</sup>

Each facility had institution-specific, written algorithms for management of intravenous and subcutaneous insulin. Both sites conducted lectures relating to management of inpatient problems, including specific aspects of inpatient diabetes, but no curriculum was specifically dedicated to the topic.

### Data Analysis

Data from survey responses from site 2 were entered for analysis at site 1. Responses of participants at both sites were analyzed using Survey Tracker version 4.0 (Training Technologies, Inc., Lebanon, Ohio). Answers were combined, and the distributions were summarized. We first analyzed the combined responses from both sites and then compared responses between sites to identify potential differences in the residents' perceptions. Differences between continuous variables were assessed using nonparametric testing. Differences in the distribution of questionnaire responses between sites were evaluated using the  $\chi^2$  test.

## RESULTS

### Demographic Characteristics of Respondents

Responses were obtained from 52 of 66 residents at site 1 and from 65 of 85 residents at site 2 ( $N = 117$  total respondents; total response, 77%). The mean age of all respondents was 31 years, 48% were men, and 85% had completed professional school during 2002 or later. The residents represented the following specialties: 61% primary care (internal medicine or family medicine;  $n = 71$ ), 27% surgical services ( $n = 31$ ), and 12% other specialties (eg, neurology, obstetrics;  $n = 15$ ).

No significant differences were found between the 2 sites in the mean age of residents (both, 31 years) or in sex distribution (both, 48% men). In addition, no significant differences were found in the distribution of training specialties (63% primary care at site 1 vs 58% at site 2).

### Perceptions About Inpatient Burden of Diabetes

Residents were asked to estimate the percentage of their hospitalized patients whom they perceived as having diabetes or hyperglycemia. Pooled data showed that 12% of residents indicated that these conditions affected 0% to 20% of their hospitalized patients, 34% estimated 21% to 40%, 30% estimated 41% to 60%, 19% estimated 61% to 80%, 3% estimated 81% to 100%, and 3% were unsure. Overall, 52% of respondents perceived that diabetes or hyperglycemia was present in >40% of their inpatients. No significant difference was noted in the distribution of responses between sites.

### Views on the Importance of Inpatient Glycemic Control

Residents were asked their opinions about the importance of good glucose control in critically ill, perioperative, and noncritically ill patients. Combined data from site 1 and site 2 showed that residents believed that glycemic control was “very important” in critically ill patients (96%), perioperative patients (82%), and noncritically ill patients (66%) (Table I).

### Comfort With Management

Survey participants were asked how comfortable they felt about different scenarios pertaining to inpatient glucose management. Combined analysis showed that only 37% of respondents were “very comfortable” with treating hyperglycemia, 41% were “very comfortable” with treating hypoglycemia, 36% were “very comfortable” with using SC insulin, and 26% were “very comfortable” with using insulin drips (Table I).

### Familiarity With Existing Policies and Procedures

Pooled analysis revealed that only a small proportion of resident physicians were familiar with existing institutional policies and order sets relating to the use of insulin pumps in the hospital; 17% of the combined residents were “very familiar” with institutional hypoglycemia policies. Knowledge about subcutaneous insulin order sets was better, with 48% of trainees familiar with these institutional protocols; however, only 29% were “very familiar” with institutional intravenous insulin order sets (Table I).

### Beliefs About Glucose Targets and Hypoglycemia

When resident physicians were asked to indicate the target glucose levels that they would like to achieve, 83% (collective data) tried to achieve a glucose range of 80 to 110 mg/dL in critically ill patients, whereas 63% chose this range for perioperative patients and 48% aimed for this target in noncritically ill patients (Table I). When asked to

**Table I.** Combined responses of 117 medical residents at site 1 and site 2. Values are percentages unless indicated otherwise.

Response Options	Response			
	Very Important	Somewhat Important	Not at All Important	Don't Know
Importance of treating hyperglycemia in:				
Critically ill patients	96	4	0	0
Perioperative patients	82	18	0	0
Noncritically ill patients	66	33	1	0
Response Options	Very Comfortable	Somewhat Comfortable	Not at All Comfortable	Don't Know
Comfort level with:				
Treating hyperglycemia	37	56	7	0
Treating hypoglycemia	41	54	4	1
Using subcutaneous insulin	36	53	10	1
Using insulin drips	26	40	32	2
Response Options	Very Familiar	Somewhat Familiar	Not at All Familiar	
Familiarity with institutional:				
Insulin pump policy	6	34	60	
Insulin pump order set	4	33	63	
Hypoglycemia policy	17	47	36	
Subcutaneous insulin orders	48	30	22	
Intravenous insulin orders	29	42	29	
Response Options	80–110 mg/dL	111–180 mg/dL	181–250 mg/dL	Don't Know
Glucose target in:				
Critically ill patients	83	14	1	2
Perioperative patients	63	31	1	5
Noncritically ill patients	48	49	1	2

identify the glucose level at which they first considered a patient to be hypoglycemic, 25% chose a value of <70 mg/dL, 53% chose a value of <60 mg/dL, 15% chose a value of <50 mg/dL, 4% chose a value of <40 mg/dL, and the remaining 3% were unsure.

**Between-Site Differences in Perceptions About Inpatient Diabetes Management**

The degree of comfort that residents felt in managing insulin drips was significantly different between the 2 sites ( $P < 0.01$ ), with more residents at site 2 being “very comfortable” using insulin drips (Table II). There was greater familiarity among residents at site 1 than among those at site 2 with their hospital’s insulin pump policy and insulin pump order set ( $P < 0.01$  for both questions), although the proportion who were “very familiar” was low at both sites. More trainees at site 1 than at site 2 indicated that they were familiar with their

hospital’s subcutaneous insulin order set, whereas residents at site 2 had greater familiarity than those at site 1 with their institutional intravenous insulin order sets (Table II).

A comparison of responses between sites suggested that residents at site 2 may be more aggressive than those at site 1 in the glucose targets they set for critically ill patients ( $P = 0.03$ ) and perioperative patients ( $P = 0.007$ ). A greater number of respondents at site 2 opted for glucose target ranges of 80 to 110 mg/dL (Table II). No significant differences in the distribution of responses were detected between the sites for any other questions.

**Perceived Barriers to Care**

Trainees were asked to choose from a list of factors that they perceived as obstacles to inpatient glucose management. The most common barrier expressed by residents at both sites was “knowing what insulin type or regimen

**Table II.** Significant differences in medical residents’ perceptions about inpatient diabetes management, by site. Values are percentages unless indicated otherwise.

Response Options	Response				P
	Very Comfortable	Somewhat Comfortable	Not at all Comfortable	Don’t Know	
Comfort level with insulin drips:					
Site 1	11	39	48	2	<0.01
Site 2	39	41	18	2	
Response Options	Very Familiar	Somewhat Familiar	Not at all Familiar		
Familiarity with institutional:					
Insulin pump policy					
Site 1	2	58	40	<0.01	
Site 2	9	16	75		
Insulin pump orders					
Site 1	2	54	44	<0.01	
Site 2	6	17	77		
Subcutaneous insulin orders					
Site 1	65	25	10	<0.01	
Site 2	35	34	31		
Intravenous insulin orders					
Site 1	16	54	30	0.01	
Site 2	39	32	29		
Response Options	80–110 mg/dL	111–180 mg/dL	181–250 mg/dL	Don’t Know	
Glucose target in:					
Critically ill patients					
Site 1	73	25		2	0.03
Site 2	91	6	2	1	
Perioperative patients					
Site 1	48	40	2	10	0.007
Site 2	75	23		2	

works best" (Table III). In pooled data, the "risk of causing hypoglycemia" ranked second, followed by "unpredictable changes in patient diet and mealtimes," "unpredictable timing of patient procedures," and "knowing how to adjust insulin" (Table III).

## DISCUSSION

Improving inpatient diabetes management and glucose control has emerged as an important quality-of-care concern. National and regional organizations have begun to focus greater attention on the management of hospital hyperglycemia by introducing and promoting guidelines for better care.<sup>5,7,13,15,16</sup> Before hospitals can develop quality improvement and educational programs that focus on inpatient hyperglycemia, they will need more insight into how their health care practitioners view the importance of inpatient glycemic control and the problems that they perceive as needing to be overcome to successfully manage hyperglycemia. Resident physicians are an ideal group to study first, because educational sessions on treatment of inpatient hyperglycemia can potentially be incorporated into existing training schedules.

National and regional organizations have begun to focus greater attention on the management of hospital hyperglycemia by introducing and promoting guidelines for better care.

Surveys such as the one described here will need to be conducted in different hospital settings to better determine whether there are common beliefs about the management of inpatient diabetes. Although both sites in our study have academic teaching programs, they are otherwise quite distinct in terms of their geographic location and the patient population they serve. Despite these institutional differences, however, we did find that resident physicians at both sites shared similar beliefs about inpatient diabetes management and had common knowledge deficits that could be targeted for educational intervention.

Resident physicians in both training programs considered diabetes to be a substantial part of their inpatient practices, although their perceptions may not reflect the actual epidemiology of diabetes in the 2 institutions.<sup>10,20</sup> However, the purpose of this paper was not to correlate resident perceptions with actual epidemiology, which would require a prospective analysis documenting cases by chart review as a resident rotates through an inpatient service; electronic records (because of incorrect coding—a known problem with inpatient diabetes) may not be an accurate means of correlating perception of epidemiology with actual prevalence. Nonetheless, trainee perceptions that inpatient diabetes constituted a large treatment burden substantiate the need to provide pertinent information and essential tools so that these physicians can manage the disease more successfully. We also established that most of the residents surveyed in this study shared a common belief that good glucose control was "very important" in situations relating to critical illness, noncritical illness, and the perioperative period. These

**Table III.** Factors that medical residents (N = 117) perceive as barriers to inpatient glucose management.

Factor	Response, No. (%)
Knowing what insulin type or regimen works best	58 (50)
Risk of causing hypoglycemia	46 (39)
Unpredictable changes in patient diet and mealtimes	45 (38)
Unpredictable timing of patient procedures	40 (34)
Knowing how to adjust insulin	34 (29)
Knowing best options to treat hyperglycemia	33 (28)
Patient not in hospital long enough to control glucose adequately	33 (28)
Shift changes and cross-coverage lead to inconsistent management	28 (24)
Knowing when to start insulin	25 (21)
Lack of guidelines on how to treat hyperglycemia	24 (21)
Preferring to defer management to outpatient care or to another specialty	23 (20)
Knowing how to start insulin	22 (19)
Glucose management not adequately addressed on rounds	22 (19)
Knowing how to best prevent hypoglycemia	18 (15)
Treating hyperglycemia is not a priority in the hospital	16 (14)
None, I have no trouble treating hyperglycemia in the hospital	11 (9)
Other	9 (8)
Disagreement with other team members on how to control glucose	7 (6)
No response	5 (4)

data suggest that trainees are getting the message that good glucose control is important in these clinical scenarios.

Despite rating highly the importance of inpatient glyce-mic control, we found that <50% of respondents (pooled data) felt “very comfortable” in managing hyperglycemia and hypoglycemia, applying subcutaneous insulin, or using insulin drips; most said that they felt only “somewhat com-fortable” or “not at all comfortable.” More respondents at site 2 than at site 1 were “very comfortable” with insulin drips, which most likely reflects the impact of a quality-improvement initiative on insulin drips that was carried out at site 2 before administration of the questionnaire.<sup>21</sup> Whether these comfort levels correlate with the quality of inpatient glucose control or application of insulin therapy is an impor-tant topic for future study.

Residents at both institutions believed in glucose target ranges that would be within current guidelines for critically ill, noncritically ill, and perioperative patients, although residents at site 2 had lower glucose targets for the periop-erative and critically ill patient populations, which suggests that they may be more aggressive in the management of these individuals.<sup>5,7</sup>

This analysis revealed some common knowledge deficits about institutional policies related to various aspects of in-patient glucose management. For instance, residents at both institutions were typically not “very familiar” with policies or order sets pertaining to insulin pumps and hypoglycemia. Although trainees at site 1 were more familiar overall than those at site 2 with their institutional insulin pump policy and order set, the percentage at site 1 that were “very familiar” was still quite low. This finding was surprising given that the first published guidelines for this mode of insulin delivery in the hospital were developed at site 1 before they were adopted at site 2.<sup>22</sup> More respondents at site 2 than at site 1 were familiar with their institution’s intravenous insulin orders, which likely reflects the prior quality-improvement initiative that focused on the use of intravenous insulin.<sup>21</sup> One of the first steps to enhancing and standardizing care of hospital glucose management may simply be to make certain that clinicians are familiar with the policies already in place at their institution.

One of the consistent findings in the surveys conducted at both sites was how residents viewed insulin therapy. This was also found when inpatient midlevel staff (nurse practi-tioners and physician assistants) were surveyed separately.<sup>18</sup> In addition to expressing low degrees of comfort and famil-iarly with specific aspects of care, such as the use of insulin drips, residents reported that “knowing what insulin type or regimen works best” was the most frequent obstacle to care. It is not known whether the perceived degree of comfort with insulin management is an overestimation or underestimation of actual skills of the residents. However, it may come as no surprise that the respondents viewed insulin treatment as a major barrier to inpatient glucose management. The number of insulin analogues has increased in recent years, and there is a large array of intravenous insulin algorithms from which to choose; the numerous options may be causing confusion

among practitioners about which type of insulin is the best or about which dosing approach to use in the hospital.<sup>23,24</sup>

Moreover, errors in insulin administration are among the most frequently occurring medication errors in the hospital, which may only serve to heighten anxiety about the drug.<sup>25</sup> The practitioners’ comfort level with insulin use is likely linked directly to the comfort they report when managing diabetes—perhaps the less confident they are in using insu-lin, the less confident they are in tackling the disease. Guide-lines about when to initiate insulin therapy, how to choose from numerous insulin treatment options, and how to adjust therapy in rapidly changing clinical situations should be integrated into any educational effort designed to improve inpatient glucose management.

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Other reported obstacles to appropriate care suggest system-based problems. “Unpredictable changes in patient diet and mealtimes” and “unpredictable timing of patient procedures” were among the 5 most frequently cited barriers to management of inpatient diabetes and ranked high at both institutions.<sup>17–19</sup> Other reported barriers, such as “patient not in hospital long enough to control glucose ade-quately” and “shift changes and cross-coverage lead to in-consistent management,” also suggest system-based prob-lems that might impair the clinician’s ability to successfully meet glucose targets in hospitalized patients. Some obsta-cles, such as the length of the hospital stay or the timing of inpatient procedures, would be difficult to reengineer. How-ever, other obstacles to care (eg, adjusting insulin therapy to mealtimes, ensuring standardization of treatment across shifts) could be addressed through institution-wide educa-tion and changes in policies.

Although it is important to understand resident physi-cians’ beliefs, their beliefs about inpatient diabetes should not be extrapolated to other medical staff members, such as attending physicians. It would also be of interest to com-pare knowledge about inpatient diabetes management between different types of training programs (eg, surgery vs internal medicine) and years of training. However, the sample sizes used here are not sufficient to allow mean-ing-ful comparisons. More surveys such as this one should be conducted in various kinds of hospitals (eg, urban, rural, nonacademic) to determine whether physicians share com-mon perceptions about inpatient diabetes care. The ques-tionnaire that we used can be adapted to investigate how other groups of health care professionals view inpatient glucose management.<sup>18</sup> With increasing numbers of respon-

dents, survey results could then be compared among different specialties (eg, family medicine, internal medicine, surgery).

## CONCLUSIONS

Results of this analysis indicate that resident physicians who are training in very different hospitals share beliefs, knowledge deficits, and perceived barriers about inpatient glucose management. Knowledge deficits and concerns over insulin treatment were present despite the existence of lectures about inpatient diabetes occurring at both institutions and suggest that some other approach to educating residents on this topic is needed. In response, site 1 has constructed a series of online training modules on inpa-

tient diabetes for use by resident physicians. These modules are now in the pilot phase and heavily emphasize instruction in some of the areas identified in the surveys as needing improvement, such as optimal dosing and administration of insulin and review of existing hospital policies and procedures pertaining to glucose management. These and other strategies to overcome perceived and actual barriers to care should be designed and tested to achieve the desired improvement in management of hospital hyperglycemia and diabetes.

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