



## ORIGINAL ARTICLE

### Interns' viewpoints and knowledge about management of hyperglycemia in the hospital setting<sup>☆</sup>

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Received 13 March 2012; accepted 14 May 2012

Available online 20 September 2012

#### KEYWORDS

Diabetes;  
Hospital;  
Inpatient  
hyperglycemia;  
Interns;  
Medical education;  
Hyperglycemia

#### Abstract

**Background and objective:** In many hospitals, adequate glycemic control is not achieved despite implementation of new insulin therapy protocols. Our aim was to assess resident physician' attitudes toward inpatient hyperglycemia, barriers to achieve optimum control, and the impact on them of an insulin training program.

**Material and methods:** A questionnaire was used to assess understanding and standard management of hyperglycemia before and six months after implementation of an inpatient insulin treatment program.

**Results:** Twenty-five interns completed the questionnaire. Glycemic control was considered "very important" in all admission situations, but was only considered "very important" in conventional hospitalization by 36% of interns. Most of these felt "comfortable" using sliding scales, but not with the basal/bolus regimen, which was the least commonly used. Perception of number of well-controlled patients and comfort and use of basal/bolus therapy increased at six months, but use of "sliding scales" remained high. The greatest difficulty reported for adequate management of hyperglycemia was the lack of knowledge.

**Conclusions:** Most residents are aware of the importance of adequate glycemic control, but cannot achieve it because of inadequate knowledge. The insulin training program led to an improved perception and applicability of basal-bolus insulin regimens. However, despite all efforts, use of sliding scales remains high. Training programs should emphasize management of hyperglycemia.

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<sup>☆</sup> Please cite this article as: Biagetti B, et al. Tratamiento de la hiperglucemia en el hospital. Impresiones y conocimientos del médico residente. Endocrinol Nutr. 2012. 2012;59(7):423-8.

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**PALABRAS CLAVE**

Diabetes;  
Hospitalización;  
Hiperglucemia en  
hospitalizados;  
Residentes;  
Educación médica;  
Hiperglucemia

## Tratamiento de la hiperglucemia en el hospital. Impresiones y conocimientos del médico residente

**Resumen**

**Antecedentes y objetivo:** En muchos hospitales se han instaurado nuevos protocolos de insulino terapia, a pesar de lo cual, no se logra un adecuado control. Evaluamos mediante una encuesta, la percepción de los médicos residentes ante la hiperglucemia, determinamos las barreras para obtener un óptimo control, y el impacto en las mismas de un programa de insulinoización.

**Material y métodos:** Se aplicó un cuestionario, que valoraba el grado de conocimiento y la práctica habitual ante la hiperglucemia, antes y a los 6 meses de la implantación de un protocolo de insulino terapia intrahospitalario.

**Resultados:** Completaron el cuestionario 25 residentes. El control glucémico se consideró «muy importante» en todas las situaciones de ingreso; sin embargo, en la hospitalización convencional solo lo consideró el 36%. La mayor parte se sentían «cómodos» utilizando la pauta de «solo insulina rápida», que fue la más empleada, pero no con la pauta basal/bolo que era «poco/nada» utilizada. A los 6 meses, aumentó la percepción del número de pacientes bien controlados, el bienestar y utilización de las pautas basal/bolo, aunque el empleo de «solo insulina rápida» se mantuvo. La mayor dificultad referida para un adecuado manejo de la hiperglucemia fue la falta de conocimientos.

**Conclusiones:** Los facultativos residentes conocen la importancia de un adecuado control, pero la falta de conocimientos impide obtenerlo. El programa formativo y la protocolización conllevaron una mejora en la percepción y aplicabilidad de las pautas intensificadas. Sin embargo, a pesar del esfuerzo, sigue siendo elevado el empleo de pautas basadas exclusivamente de insulina rápida. En el programa formativo de los residentes debería destacarse el manejo de la hiperglucemia.

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## Introduction

Poor glycemic control in hospitalized diabetic patients is associated with increased morbidity and mortality and a resultant increase in healthcare costs.<sup>1-5</sup> While 10 years ago hyperglycemia was ignored and there were no guidelines concerning its treatment, there is now overwhelming evidence showing the harmful effects of both hyperglycemia<sup>6-10</sup> and hypoglycemia<sup>11</sup> and the benefits of basal-bolus schemes over schemes using rapid-acting insulin alone (sliding scales).<sup>12,13</sup> In addition, different management guidelines recommending different goals have been published.<sup>14-20</sup>

Hospitals have gradually implemented insulin administration protocols and different approaches regarding the training of physicians in charge of patients at the different hospitalization units. However, despite all efforts, adequate control is difficult to achieve, especially in big hospitals,<sup>21-24</sup> in part because we do not know the obstacles that are preventing the application of protocols and, thus, the achievement of adequate glycemic control.<sup>24,25</sup>

In our hospital, the team responsible for disseminating the importance of the management of diabetes in the hospital setting and for modifying the standard treatment schemes detected some resistance to change in resident physicians, who also wanted additional information. The purpose of this study was therefore to assess the perception of hyperglycemia in hospitalized patients by resident physicians, and to ascertain both the barriers to achieving optimum glycemic control and the impact on them of an insulin administration protocol used in a city-based teaching hospital.

## Materials and methods

The study was conducted on 25 resident physicians at a teaching hospital in Barcelona. The residents were sequentially selected from the emergency on-call duty program, and all residents who volunteered to participate were enrolled. The residents belonged to different medical specialties, internal medicine, and family medicine. They were all in charge of inpatients and performed on-call duties in their respective hospital wards and in the emergency room. Residents in endocrinology and nutrition were excluded because they have a specific training program.

The study was conducted in compliance with the ethical principles of the Declaration of Helsinki and Good Clinical Practice guidelines, and was approved by the ethical and clinical research committee of the hospital.

A questionnaire was administered during 2009 and 2010, before and six months after the implementation at the hospital of an insulin administration protocol for stable patients admitted to hospital wards, for which training and sensitization sessions on the subject for healthcare staff, both physicians and nurses, were initially held. These sessions were followed by a more practical second phase concerned with the application of insulin schemes which was divided into two clinical sessions.

## Description of the questionnaire

The questionnaire, available online as an annex, was anonymous and adapted from the Cook et al. questionnaire.<sup>26</sup> It

focused on the different aspects of hyperglycemia in inpatients and consisted of the following sections:

1. The prevalence, significance, and degree of glycemic control in inpatients.
2. The control goals in the different admission situations.
3. Familiarity and comfort with the different treatment schemes.
4. Personal routine clinical practice.
5. The obstacles preventing good glycemic control.

The glycemic control goals considered as acceptable ( $<126$  mg/dL after fasting and all controls  $<180$  mg/dL)<sup>16</sup> were those established in the most recent recommendations of the American Diabetes Association and the Spanish Diabetes Association.<sup>17,20</sup>

SPSS 11.5 software was used for data analysis, and the group distribution of responses was examined. Quantitative variables are given as absolute values or percentages. Differences between subgroups were assessed using a Chi-square test. A value of  $p < 0.05$  was considered statistically significant. The obstacles to achieving adequate glycemic control reported by the surveyed residents were also listed in decreasing order of frequency.

## Results

Fifty anonymous questionnaires completed by the 25 resident physicians surveyed before and six months after the implementation of the protocol and the training sessions were analyzed. Residents were in the following departments: 32% in internal medicine ( $n=8$ ), 20% in family medicine ( $n=5$ ), and 48% in the remaining medical departments ( $n=12$ ).

### Prevalence, significance, and degree of glycemic control in inpatients

When asked how many patients experienced hyperglycemia during their stay at their respective units, 18% of residents answered 21–40% of their patients, while 41% thought that hyperglycemia occurred in 41–60%, and 23% that 61–80% of their patients experienced hyperglycemia. Eighteen percent of residents did not know the answer, and no residents thought that hyperglycemia occurred in less than 20% of their patients.

As regards the significance of glycemic control, most of the residents surveyed thought that it was "quite" or "very important" (Table 1). Glycemic control was considered to be "very important" in critical patients by 63% and in pregnant women by 87%, while in general wards it was considered very important by only 36%.

After the implementation of the protocol and the training sessions, the proportion of residents who considered control at conventional wards as "very important" significantly increased from 36% to 54%. In addition, 100% of residents surveyed assessed glycemic as "very" or "quite important", and no significant differences in the significance of control were detected in any admission situations after the training sessions.

As regards the proportion of patients adequately controlled during admission (Table 1), 77% of the residents surveyed said that control was achieved in less than half the cases. After the implementation of the program, 54% of residents thought that control had been achieved in most of them.

### Glycemic control goals

When asked about the control goals in the different units and conditions during admission (Table 1), most residents surveyed (68%) answered that in intensive care units the glycemic goal should range from 80 to 126 mg/dL, while 23% named values ranging from 126 to 180 mg/dL, and 9% did not know. In general wards, 14% considered glucose levels ranging from 80 to 110 mg/dL and 72% values ranging from 80 to 126 mg/dL to be adequate, while 4% did not know. In surgical units, 82% reported blood glucose levels less than 126 mg/dL as the desirable goal, and 14% did not know. After the program, the most striking change in glycemic goal occurred in general wards, where the proportion of residents who considered a strict glucose control (80–126 mg/dL) as the most adequate response more than doubled, from 14% to 37% ( $p < 0.05$ ). No change was seen in responses regarding patients admitted to intensive care units and in the perioperative period.

### Familiarity and comfort with treatments

When asked if they felt comfortable when treating hyperglycemia, 59% of residents answered that they felt "not very comfortable/uncomfortable". After protocol implementation, however, 76% felt "quite or very comfortable" and none felt "not very comfortable/uncomfortable" ( $p < 0.05$ ) (Table 1).

As regards the different forms of insulin administration, most of the physicians surveyed were "very accustomed" to using insulin schemes with "rapid-acting insulin alone" and 86% were "a little/not accustomed" to the basal/bolus scheme. After six months, significant changes were only seen in the use of basal/bolus insulin therapy, to which 55% of residents ( $p < 0.001$ ) were "a little or quite accustomed".

### Standard clinical practice

When asked about the schemes routinely used by them, 67% reported that they used "very often" or "quite often" the "rapid-acting insulin alone" scheme, and 62% used "little/not at all" basal/bolus insulin therapy. After six months, 73% used basal/bolus insulin therapy "very or quite often". However, the "rapid-acting insulin alone" scheme continued to be routinely used by more than half the residents (55%). The use of intravenous insulin therapy did not change after the program.

### Barriers to achieving adequate control

As regards the barriers preventing the achievement of adequate control (Table 2), a number of items were listed and several responses could be given to each item in

**Table 1** Opinions of resident physicians about hyperglycemia in the hospital setting before and after the training sessions.

Category	Response								
Importance of treating hyperglycemia	Very important		Quite important		Somewhat important		I do not know		<i>p</i>
	B	A	B	A	B	A	B	A	
Intensive care unit	62	63	19	28	18	9	0	0	n.s
General ward	36	64	54	36	10	0	0	0	<0.0001
Perioperative period	55	73	40	27	5	0	0	0	n.s.
Pregnant women	87	90	13	10	0	0	0	0	n.s.
Proportion of well-controlled patients	<20%		21-50		>50%		I do not know		<i>p</i>
% of responses	28.5	0	48.5	45.5	10	54.5	13	0	<0.001
Glucose control goal, mg/dL	80–110		80–126		126–180		I do not know		<i>p</i>
Intensive care unit	32	37	36	28	23	35	9	0	n.s
General ward	14	37	72	47	9	16	5	0	<0.0001
Perioperative period	27	27	55	63	4	10	14	0	n.s.
Grade of comfort with treatment	Very comfortable		Quite comfortable		Somewhat comfortable		Not very comfortable/ uncomfortable		<i>p</i>
Treating hyperglycemia	13	36	29	40	19	24	59	0	<0.0001
Using SC insulin	4	9	37	72	19	10	40	9	<0.0001
Using insulin pumps	9	9	12	14	18	22	1	55	n.s.
Familiarity with treatment	Very accustomed		Quite accustomed		Somewhat accustomed		A little/not accustomed		<i>p</i>
“Rapid-acting insulin alone” scheme	40	37	22	27	19	18	19	18	n.s.
Basal/bolus insulin therapy	0	0	5	19	9	36	86	45	<0.0001
Intravenous insulin therapy	4	8	2	2	18	27	76	63	n.s.
Standard clinical practice	Very often		Quite often		Not often		Little/not at all		<i>p</i>
“Rapid-acting insulin alone” scheme	37	27	28	28	24	17	11	28	<0.0001
Basal/bolus insulin therapy	84	46	18	27	10	10	62	17	<0.0001
Intravenous insulin therapy	59	9	5	9	37	27	53	55	n.s.

Data given as percentage of total responses (n = 25), SC: subcutaneous. B, before; A, after; n.s., not significant.

**Table 2** Barriers perceived by residents for the adequate management of hyperglycemia in the hospital setting.

	Number of responses	%
Understanding and switching between the different types of insulin and their dosage forms	17	68
Understanding the adjustment of insulin schemes	14	58
Understanding when insulin therapy should be started	12	47
The identification of the best option for treating hyperglycemia	8	31
Knowledge of the guidelines for treating hyperglycemia	5	21
The risk of inducing hypoglycemia	1	5
The treatment of hyperglycemia is not a priority for me	1	5
None, I have no problem in diabetes management	0	0

order of priority. No option was ignored by the residents, and the three options most commonly selected were: "Understanding and switching between the different insulin types", "Understanding of treatment adjustment", and "Ignoring when to start treatment"; moreover, only 5% of the residents surveyed answered "hyperglycemia is not a priority" and "I am limited by the risk of hypoglycemia".

## Discussion

Glycemic control of patients admitted to hospital has become increasingly relevant in recent years, and control goals have been established.<sup>19</sup> Despite these recommendations, basal/bolus insulin schemes are difficult to implement in many hospitals due to lack of information, training, or even the routine use of new algorithms, among other reasons.

Insulin is the treatment recommended for patients admitted to hospital for some time, and in recent years the marketing of different insulin analogues has promoted the use of the more physiological and standardized basal/bolus schemes to the detriment of schemes based on rapid-acting insulin alone. These advances have led to a proliferation of algorithms of both subcutaneous and intravenous insulin therapy, and different options, most of them effective, are available. The selection of the best alternative and the adjustment of the different schemes has somewhat complicated the management of admitted diabetic patients and requires an additional effort in the training of healthcare staff for diabetes treatment.

Our results agree with those reported in previous studies.<sup>25-28</sup> However, no study comparing changes in attitude both before and after the implementation of a training program specifically for residents was available at the time of writing the manuscript.

In our hospital, the resident physicians thought that the treatment of diabetes was a significant part of their healthcare activity, had an exaggerated perception of the prevalence of hyperglycemia in hospitalized patients, as 64% answered that more than 40% of their patients were diabetics, and moreover, thought that these patients were usually inadequately controlled. This latter opinion had substantially changed by the end of the program and after the implementation of the insulin therapy protocol. The residents also considered glycemic control in the different hospitalization units important, particularly in intensive care units and in pregnant women, although it appeared to be less relevant and the normoglycemic goal was more flexible if the patient was admitted to a general ward. This perception had also changed by the end of the program, when the residents were more aware of the significance of adequate control during hospital admission.

Most residents did not feel comfortable with the treatment of hyperglycemia. This attitude had clearly changed by the end of the program, when residents felt more comfortable with basal/bolus schemes, maybe because the unification of the criteria had decreased their feelings of uncertainty regarding treatment.

Although their opinion about the advantages and use of basal/bolus insulin schemes significantly improved, a high number of residents continued to use schemes based on

rapid-acting insulin alone. This may partly be explained by so-called "therapeutic inertia", but it is also possible that our training program was not intensive enough or that there were difficulties in understanding or in the electronic prescription of the new algorithms. We agree in this regard with Kirk and Oldham,<sup>29</sup> who suggested that pharmacy departments should be implicated in these programs to promote the basal/bolus scheme and to facilitate the use of current insulin therapy protocols.

Finally, among the limitations preventing adequate control, most of the residents surveyed reported aspects related to inadequate understanding of treatments, partly due to the increased use of insulin analogues (new insulins) without adequate training. Twenty-one percent of residents cited "ignorance of guidelines" as an obstacle and, surprisingly, only 5% said that they felt limited by "fear of hypoglycemia", although this finding agrees with prior studies.<sup>25,26</sup>

The main limitation of this study was its small sample size, which prevented comparison between the different specialties of the residents surveyed. An additional limitation was that surgical specialties were not included because we felt that these required a specific study due to the differences in the training programs of the various medical specialties. Results should not be extrapolated to the non-resident medical staff because the questionnaire was designed for training staff, although it could be used in the future for all other physicians provided some small changes were made first.

In any case, this study clearly showed that some therapeutic inertia exists, because despite the resources used and the effort made, the "rapid-acting insulin alone" scheme continued to be routinely used by 55% of residents. It also demonstrated a lack of familiarity by many resident physicians with the recommendations and procedures recommended for the control of hyperglycemia during admission, despite its high prevalence. It would therefore be convenient to include in the early stages of the training programs for the different specialties a section on the hospital management of diabetes mellitus and hyperglycemic decompensation.<sup>28</sup>

## Conflicts of interest

The authors state that they have no conflicts of interest.

## Appendix. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.endoen.2012.08.010>.

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