



Letter to the Editor

Inpatient hyperglycemia: Clinical management needs in teaching hospital[☆]



Dear Editor,

The prevalence of hyperglycemia among hospitalized patients is 32%–38% [1]. Observational studies have demonstrated an increase in complications, hospital stay, and use of resources, despite 30% of these subjects not having a diagnosis of diabetes mellitus (DM) [1,2,4]. It is known that insulin plays an important role in the prevention of complications associated with hyperglycemia, and could be helpful in hospitalized patients with hyperglycemia [3]. Generally the identification of hyperglycemia and treatment strategies used in the management of hospital hyperglycemia continue to be deficient because of many barriers [1,4]. Clinical inertia, poor hyperglycemia treatment hierarchy, its association with more “attention demanding” pathologies (myocardial infarctions, among others) and lack of established algorithms in most hospitals are some examples of those barriers [4].

The main aim of this study is to present the prevalence of hospital hyperglycemia in patients on admission as well as the differences in the treatment, other prognostic variables that affect hospital stay and mortality and the frequency of DM diagnosis.

We carried out an observational, retrospective study following the STROBE recommendations. We investigated a convenience sample in the University Hospital in Monterrey, NL Mexico from December 2010 to February 2011. Medical records of 269 patients admitted to different departments of the hospital, were reviewed. Patients of both sexes were selected consecutively, regardless of their age. Patients with incomplete records and those admitted to the Intensive Care Unit were excluded; following the consensus panel ACE/ADA for glucose target in Non-ICU patients setting [5]. Out of 269 patients that met inclusion criteria, 31 were excluded because they had no glucose determinations at admission. All others were analyzed.

Demographic variables, family history of DM and the presence of cardiovascular risk factors (DM, antihypertensive and hypolipidemic therapy, smoking, and cardiovascular disease (CVD) and chronic kidney disease (CKD)), in the medical records were collected.

Patients with hyperglycemia were defined as an admission or in-hospital fasting blood glucose level of 140 mg/dl (7.8 mmol/l) or greater [5]. Patients with hyperglycemia were subdivided into known diabetes and new onset hyperglycemia. We identified the proportion of patients with an HbA1c determination during

hospitalization and the type/scheme of treatment (oral, insulin (infusion, basal/bolus or sliding scale) or combined). In addition, we recorded the frequency that hyperglycemia was recorded on the subject's problem list.

Statistical analysis of the data was performed with SPSS version 19. Continuous variables were expressed with measures of central tendency and dispersion; in comparisons, Student's *t* test and ANOVA were used. Qualitative variables were expressed in proportions and with the χ^2 test. A $P < 0.05$ was considered significant.

A total of 269 medical records were reviewed. The demographic variables and cardiovascular risk factors can be seen in Table 1, both for overall population and for each glycemic group. The prevalence of cardiovascular risk factors is more pronounced in the hyperglycemic group, even doubling or tripling in some factors. Also, the mortality in the hyperglycemic group triples that of normoglycemic group (5% vs. 15%, $P = 0.012$). Among the hyperglycemic group, diabetic and non-diabetic patients show significant differences (Table 2). As it can be expected, a family history of diabetes is twice more common in the diabetic group. Also, cardiac risk factors such as antihypertensive therapy and hypolipemic agents are more common. It is also important to note that diabetic, hyperglycemic patients are given more attention than their not diabetic counterparts, as shown by a higher prevalence of treatment, follow up and HbA1c on admission. Finally, mortality in the diabetic group doubles the non diabetic, although this was found as not statistically significant.

The prevalence of hyperglycemia on admission was 35%, similar to literature [1,15]; however, in contrast, our proportion of de novo hyperglycemia was almost 50%. Inpatient hyperglycemia has been associated with a major risk factor for in hospital mortality, therefore we emphasize the need for universal screening of these patients [3,6,7].

Despite the high prevalence of inpatient hyperglycemia in our hospitalized population, its management is often considered secondary, especially if a history of DM does not exist. This is reflected in problem list of most patients, as 50% did not include hyperglycemia as a medical problem. If a previous history is suspected, the diagnosis should be confirmed with a determination of HbA1c or OGTT [5,8]. In our results, HbA1c determinations were performed in a small percentage of patients with hyperglycemia without DM (12%). Another major finding of our study is that, although 85% of diabetic, hyperglycemic patients were treated, only a third of those with novo hyperglycemia received treatment. Inadequate control of hyperglycemia has been associated with increased morbidity and mortality [3,6,7]. Established protocols to control inpatient hyperglycemia should be implemented to reduce these risks [5,7]. We found that most hyperglycemic patients received insulin as suggested by most published guidelines [14]. However, recent studies have shown that the use of other medications, like DPP-4 inhibitors, could provide the same amount of efficacy, with less hypoglycemic risks [13].

Finally, our study found inadequate control and follow-up of hyperglycemia in non-diabetic patients. This is reflected as 90% of

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Table 1

Demographic characteristics. Classification according to glucose levels on admission.

Variables	Overall population n = 269 (%)	Hypoglycemia n = 11 (%)	Normal n = 164 (%)	Hyperglycemia n = 94 (%)	P value
Gender (W/M)	131 (49)/138 (51)	8 (73)/3 (27)	87 (53)/77 (47)	43 (46)/51 (54)	NS
Age	37 ± 21 years	35 ± 17	39 ± 21	52 ± 20	<0.001
Family history of DM	97 (36)	2 (18)	58 (35)	46 (49)	0.034
Smoking	56 (21)		38 (23)	21 (22)	NS
Antihypertensive therapy	40 (15)	3 (27)	25 (15)	32 (34)	0.01
Diabetes mellitus	43 (16)	4 (36)	15 (9)	52 (55)	<0.001
Hypolipidemic agents	5 (2)		5 (3)	6 (6)	NS
CVD	16 (6)	2 (18)	10 (6)	15 (16)	0.026
CKD		1 (9)	10 (6)	17 (18)	0.010
Mortality		1 (9)	8 (5)	15 (16)	0.012
Days of hospital stay		3 ± 2	6 ± 5	6 ± 7	NS
Department					
Internal medicine			23 (50)	23 (50)	
General surgery		1 (6)	12 (75)	3 (19)	
Traumatology			5 (50)	5 (50)	
Plastic surgery			6 (60)	4 (40)	
Gynecology/Obstetrics		6 (15)	31 (78)	3 (8)	
Shock/trauma/observational care unit		4 (3)	79 (59)	51 (38)	
Pediatrics			8 (62)	5 (38)	

Data presented as means and standard deviation.

diabetic patients received treatment, while only 5% of the non-diabetic did.

This bears remarkable importance as it has been reported that 60% of patients admitted to the hospital with hyperglycemia develop DM within a year after their admission [1].

Our study has limitations, as this is a retrospective study, only patients with glucose levels on admission were analyzed and we did not have a follow up of the same population. Another limitation was that this was a convenience sample being cared by a heterogeneous group of healthcare providers not a specific care team. Also, there was a lack of determination of HbA1c, which is necessary to make a differential diagnosis between stress hyperglycemia and preexisting DM.

Our study suggests that community hospitals such as ours need to adopt standardized treatment protocols for inpatient

hyperglycemia. These programs should establish goals for glycemic control, incorporate algorithms for the management of hyper/hypoglycemia, promote the use of basal/bolus insulin, adequately document the diagnosis, and treat it after hospital discharge [8,9,10,11]. For this reason, in 2009, created a inpatient protocol for hyperglycemia entitled called Normoglycemia in the Hospitalized Patient (NOPHAL), which includes training work to implement an educational program that includes operational protocols with therapeutic schemes for hyperglycemia and hypoglycemia, monitoring hospitalized patients and quality indicators such as days of hospital stay and morbidity/mortality [4]. Other resources are available for treatment of inpatient hyperglycemia, like the AACE Diabetes Resource Center and others [11,12].

In conclusion, despite the high prevalence of inpatient hyperglycemia, there is an obvious lack of screening, ranking, treatment, and long-term follow-up of in-hospital hyperglycemia.

Table 2

The clinical, demographic characteristics and treatment of patients with hyperglycemia according to previous history of DM.

	Hyperglycemia with DM n = 52 (%)	Hyperglycemia without DM n = 42 (%)	P value
Gender (W/M)	27 (52)/25 (48)	16 (38)/26 (62)	NS
Age (years)	59 ± 16	44 ± 22	<0.001
Family history of DM	32 (62)	14 (33)	0.006
Smoking	8 (15)	13 (31)	NS
Antihypertensive therapy	26 (50)	6 (14)	<0.001
Evolution of DM (years)	16 ± 12		
Hypolipidemic agents	5 (10)	1 (2)	NS
HbA1c request	10 (19)	5 (12)	NS
HBA1c (%)	10 ± 2	9 ± 2	NS
Treatment	44 (85)	13 (31)	<0.001
Oral treatment	3 (6)		NS
Metformin	2 (4)		NS
Metformin/Glibenclamide	1 (2)		NS
Treatment with insulin	41 (79)	12 (29)	<0.001
Infusion pump	13 (25)	4 (10)	NS
Sliding scale insulin	13 (25)	6 (14)	NS
Basal/bolus insulin	13 (25)	1 (2)	NS
Combined therapy	2 (4)	2 (5)	NS
Days of hospital stay	6 ± 8	7 ± 6	NS
Mortality	10 (19)	5 (12)	NS
Hyperglycemia in PL	14 (27)	2 (5)	<0.01
Treatment for DM on discharge	23 (51)	2 (5)	<0.001
Appointment at OC for follow-up	18 (35)	2 (5)	<0.001

DM: Diabetes mellitus; PL: problem list; OC: outpatient clinic.

Data are presented as means and standard deviation.

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References

- Smiley D, Umpierrez GE. Management of hyperglycemia in hospitalized patients. *Ann N Y Acad Sci* 2010;1212:1–11.
- Perez-Perez A, Conthe-Gutierrez P, Aguilar-Diosdado M, Bertomeu-Martinez V, Galdos-Anunciabay P, Garcia-de-Casasola G, et al. Tratamiento de la hiperglucemia en el hospital. *Med Clin (Barc)* 2009;132(12):465–75.
- Umpierrez GE, Isaacs SD, Bazargan N, You X, Thaler LM, Kitabchi AE. Hyperglycemia: an independent marker of in-hospital mortality in patients with undiagnosed diabetes. *J Clin Endocrinol Metab* 2002;87(3):978–82.

- [4] Tamez-Perez HE, Gomez-de-Osio M, Bahena-Garcia A, Rodriguez-Valadez F, Tamez-Pena AL. Proyecto NOPHAL: una visión integradora de la hiperglucemia en el hospital. *Rev Med Inst Mex Seguro Soc* 2009;47(4):349–51.
- [5] Umpierrez GE, Hellman R, Korytkowski MT, Kosiborod M, Maynard GA, Montori VM, et al., Endocrine Society. Management of hyperglycemia in hospitalized patients in non-critical care setting: an endocrine society clinical practice guideline. *J Clin Endocrinol Metab* 2012 Jan;97(1):16–38. <http://dx.doi.org/10.1210/jc.2011-2098>.
- [6] Olveira G, García-Luna PP, Pereira JL, Rebollo I, García-Almeida JM, Serrano P, et al. Recommendations of the GARIN group for managing non critically ill patients with diabetes or stress hyperglycaemia and artificial nutrition. *Nutr Hosp* 2012;27(5):1837–49.
- [7] Umpierrez G, Maynard G. Glycemic chaos (not glycemic control) still the rule for inpatient care. *J Hosp Med* 2006;1(3):141–4.
- [8] Dombrowski NC, Karounos DG. Pathophysiology and management strategies for hyperglycemia for patients with acute illness during and following a hospital stay. *Metabolism* 2013 Mar;62(3):326–36. <http://dx.doi.org/10.1016/j.metabol.2012.07.020>. Epub 2012 Sep 20.
- [9] Giacco Ferdinando, Brownlee Michael. Oxidative stress and diabetic complications. *Circ Res* 2010;107:1058–70.
- [10] Teodoro JS, Gomes AP, Varela AT, Duarte FV, Rolo AP, Palmeira CM. Uncovering the beginning of diabetes: the cellular redox status and oxidative stress as starting players in hyperglycemic damage. *Mol Cell Biochem* April 2013;376(1–2):103–10.
- [11] American Association of Clinical Endocrinologists. Diabetes resources. Inpatient Resource Center. <http://inpatient.aace.com>.
- [12] American Diabetes Association. Standards of medical care in Diabetes—2014. *Diabetes Care* January 2014;37:S14–80. <http://dx.doi.org/10.2337/dc14-S014>.
- [13] Umpierrez GE, Gianchandani R, Smiley D, Jacobs S, Wesorick DH, Newton C, et al. Safety and efficacy of sitagliptin therapy for the inpatient management of general medicine and surgery patients with Type 2 diabetes. *Diabetes Care* 2013.
- [14] Moghissi ES, Korytkowski MT, DiNardo M, Einhorn D, Hellman R, et al. American Association of Clinical Endocrinologists and American Diabetes Association consensus statement on inpatient glycemic control. *Endocr Pract* June 2009;32(6):1119–31.
- [15] Clement S, Braithwaite SS, Magee MF, Ahmann A, Smith EP, Schafer RG, et al. Management of diabetes and hyperglycemia in hospitals. *Diabetes Care* February 2004;27(2).