

## Management of hyperglycemia in a first level care hospital

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### Abstract

**Objective:** To describe the treatment of patients who consulted the emergency department for hyperglycemia, the previous management and its probable relationship with new hyperglycemia in a first level of care.

**Materials and methods:** Observational cross-sectional study with a one-year follow-up in patients over 18 years of age with hyperglycemia who consulted in the emergency department between September-2016 and August-2017. The medical records were reviewed, and sociodemographic, clinical, and pharmacological variables were established. Descriptive statistics,  $X^2$  and binary logistic regression models ( $P < 0.05$ ) were used.

**Results:** There were 86 patients with hyperglycemia (mean age  $52.1 \pm 14.93$  years). It was found that in 58.1% of cases there was a previous diagnosis of diabetes mellitus; 87.2% were treated with crystalline insulin and 47.0% of the patients consulted again for a hyperglycemic crisis in the six months after discharge.

**Conclusion:** There is a high proportion of patients with non-ketonic, non-hyperosmolar hyperglycemia who were unaware of having diabetes mellitus. In addition, almost half of the patients consult again for a hyperglycemic attack in the following six months after discharge.

**Keywords:** Hyperglycemia; Mellitus Diabetes; emergency treatment; pharmacoepidemiology.

### Manejo de la hiperglicemia en un hospital de primer nivel de atención

#### Resumen

**Objetivo:** Describir el tratamiento en un hospital de primer nivel de pacientes que consultaron el servicio de urgencias por hiperglucemia, el manejo previo y su probable relación con nuevas hiperglucemias.

**Materiales y métodos:** Estudio observacional de corte transversal con seguimiento de un año en pacientes mayores de 18 años con hiperglucemia que consultaron en el servicio de urgencias entre septiembre-2016 y agosto-2017. Se revisaron las historias clínicas y se establecieron variables sociodemográficas, clínicas, y farmacológicas. Se empleó estadística descriptiva,  $X^2$  y modelos de regresión logística binaria ( $P < 0.05$ ).

**Resultados:** Se presentaron 86 pacientes con hiperglucemia (edad media de  $52.1 \pm 14.93$  años). Se encontró que en el 58,1% de casos había un diagnóstico previo de diabetes mellitus; 87,2% fueron tratados con insulina cristalina y el 47,0% de los pacientes consultaron nuevamente por una crisis de hiperglucemia en los seis meses posteriores al egreso.

**Conclusión:** Existe alta proporción de pacientes con hiperglucemias no cetónicas, no hiperosmolares que desconocían presentar diabetes mellitus. Además, casi la mitad de los pacientes consultan nuevamente por crisis de hiperglucemia en los siguientes seis meses después del alta.

**Palabras claves:** Hiperglucemia; diabetes mellitus; tratamiento de urgencia; pharmacoepidemiología.

## Introduction

Hyperglycemia is a medical emergency of metabolic origin that can occur in patients with or without a previous history of diabetes mellitus (DM); If not treated promptly and properly, it can result in complications such as shock, coma, and even death (1).

There are factors by which blood glycemia levels can increase, such as infections, drug use, inappropriate use of insulin therapy and the most common: DM (2,3). In the case of patients with DM, one of the main acute complications is diabetic ketoacidosis (DKA) and the hyperosmolar hyperglycemic state (HHS), with a mortality rate of up to 20% (1). HHS occurs in 30-40% of cases as the first manifestation of metabolic disease (4) and has a higher mortality than DKA, with a considerable proportion of 5 to 20% (4); however, the majority of hyperglycemia in patients who visit the emergency department (diabetic or without this diagnosis) do not develop ketoacidosis or hyperosmolarity (1,4).

Simple hyperglycemia, understood as a glycemia greater than 180 mg / dL in the absence of diagnostic criteria for DKA or HHS in patients with or without diabetes, it constitutes a health problem due to the high mortality rate secondary to its complications, mainly cardiovascular, in addition to admission to intensive care units, the increase in hospital stays and the higher frequency of infections (4,5).

For the management of this pathology, multidisciplinary management is required, identifying the first stages in order to establish prompt treatment (6,7) to rehydrate the patient, correct blood glycemia levels, electrolyte balance and identify possible comorbidities that make it difficult to control the disease (2,6)

Insulin therapy should be started after providing adequate hydration and early identification of serum potassium levels to determine the need for electrolyte replacement, provided that hyperglycemia control has not been achieved with initial treatment (2,6). Management is given intravenously at a dose of 0.1 IU / kg / hour diluted in sodium chloride (2,6), with glucose monitoring every hour, aiming at levels less than 300mg / dl for HHS or 200 for DKA, at which time the infusion is decreased to 0.01-0.05 IU / Kg / h in order to avoid hypoglycemia; however, a large proportion of patients with hyperglycemia in the emergency room do not have criteria for these two entities and management should be more conservative and focused on rehydration, in addition to establishing the cause (6,9).

Hyperglycemia can cause damage to multiple systems and organs, increasing health care costs (9). Therefore, it is important to make a timely diagnosis and proper

management in the emergency services to reduce possible complications. In the case of Colombia, the prevalence of hyperglycemic seizures in the general population has not been described. A prevalence of 5.2% adjusted by age is described, estimating approximately one and a half million people with type 2 DM, the main risk factor for hyperglycemia (8); however, there is little information on the characteristics of patients who consult for hyperglycemia (in patients with or without DM) to the emergency department, the classification or the treatment provided, which is why the objective of this description was to determine the treatment used in patients with a diagnosis of hyperglycemia who consulted an emergency department, the previous management that the patient was receiving before the crisis and the variables that may be associated with new episodes of subsequent hyperglycemia.

It should be noted that this research has the ethical approval of the Bioethics Committee of the Universidad Tecnológica de Pereira as a risk-free research through Act # 25 issued on February 6, 2017, as well as the institutional approval of the same and the principles of confidentiality given by the Declaration of Helsinki (10) were respected.

## Materials and methods

Observational study that included patients of both sexes, older than 18 years, treated in the emergency service of Hospital San Pedro y San Pablo in La Virginia, Risaralda, Colombia, who presented signs, symptoms and diagnosis of hyperglycemia (glycemia > 180 mg / dL); during the period from September 1, 2016 to August 31, 2017.

The information was obtained from the medical records of the patients treated in the emergency department, with prior authorization from the hospital center, identified through the codes of the International Classification of Diseases (ICD 10) (R739, E102, E141, E101, E121) with the collaboration of the hospital's systems department. The entire population served in the study period was analyzed. A database was built with the information recorded by the doctors in the medical records, obtaining the following variables:

### 1. Sociodemographic:

Age, sex, marital status, origin, type of affiliation to the General System of Social Security in Health (SGSSS for the acronym in Spanish) (subsidized, contributory regime).

### 2. Previous characteristics of the patients:

Background (yes / no): diabetes mellitus, control appointment before the crisis, days since last control visit (number of days), previous

glycosylated hemoglobin (HbA1c), previous baseline treatment (name of drugs, presentation, concentration, daily dose for each).

### 3. Attention in emergencies:

- Symptoms on admission.
- Paraclinicals requested (yes / no): blood glucose at admission (mg / dL), blood count, creatinine, urinalysis, urea nitrogen, potassium, control of potassium, sodium, arterial gases, plasma osmolarity.
- Emergency treatment for hyperglycemia (yes / no): intravenous fluids, bolus administration, infusion administration, amount of intravenous fluids administered (ml), insulin management, types of insulin, dose in International Units (IU), method of administration (single dose, bolus, infusion), route of administration (venous / subcutaneous), insulin infusion time (hours), potassium infusion, hypoglycemia.
- Treatment after hyperglycemia (yes / no): type of treatment received: 1. Baseline bolus insulin scheme; 2. Mobile insulin scheme where crystalline insulin is used before each meal and before going to bed if the glucometry is greater than 140mg / dl in patients with oral route. In patients without oral route, crystalline insulin is administered 6 times a day; if the blood glucose level persists above 140mg / dl, add 2 IU to each dose) (9); performance of control blood glucose tests (frequency in hours, discharge blood glucose test, discharge blood glucose test value, third-level referral).

Additionally, the cases that presented hyperglycemia in the first and sixth months after discharge from emergency care were identified; furthermore, those who required hospitalization in the first six months after at discharge from the clinical records of each patient.

For the analysis of the information, the statistical package SPSS Statistics, version 22.0 (IBM, USA) Windows was used. Descriptive statistics were used.  $\chi^2$  tests were performed for the comparison of categorical variables. Binary logistic regression models were applied using as dependent variables having presented a new hyperglycemia the first month after discharge from emergency care (yes / no), as well as having presented a hospitalization six months after discharge from emergency care (yes / no) with the independent variables that were statistically significantly associated in the bivariate analyzes. A  $p < 0.05$  was established as a level of statistical significance.

## Results

86 patients with hyperglycemia were identified during the study period with a mean age of  $52.1 \pm 14.9$  years. The main sociodemographic characteristics of the population are described in Table 1.

**Table 1.** Sociodemographic characteristics

Variable name	n	%
<b>Sex</b>		
Woman	52	60.5
Age (<60/>60) years-old	26/60	30.2/69.8
<b>Civil status</b>		
Single, separated	55	64.0
Married, common law	31	36.0
<b>Area</b>		
Rural	71	82.6
Urban	15	17.4
<b>Affiliation to the General System of Social Security in Health</b>		
Subsidized regime	55	64.0
Others	31	36.0

### 1. Previous characteristics of the patients

It was found that 36 patients (41.9%) had not previously been diagnosed with DM. Of these, in 50 cases DM had been previously diagnosed; in 10 cases (20.0%) there was no report of HbA1c and in 29 cases (72.5%) there were values outside the goals.

The most prescribed oral antidiabetic drug was metformin (30.2%) and 44.2% of the patients ( $n = 37$ ) used insulin. The characteristics prior to the emergency consultation of the patients are described in Table 2:

**Table 2.** Previous characteristics of the population.

Variable name	n	%
Diagnosis of diabetes mellitus	50	58.1
Control appointment before the crisis	50	100.0
Days since last control consultation		
Mean / SD * (days)	336.8/611.3	
Maximum value (days)	3343	
Minimum value (days)	2	
Patients with previous HbA1c **	40	80.0
Target HbA1c patients	11	27.5
Background treatment with doses		
Metformin tablet 850mg	26	30.2
2550 mg/day	18	20.9
850 mg/day	7	8.1
1750 mg/day	1	1.2
Glibenclamide tablet 5 mg	6	6.9
10 mg/day	4	4.6
15 mg/day	2	2.3
<i>Insulins</i>		
Glargine	23	26.7
(mean / SD) IU / day	33.35/11.99	
NPH	15	11.5
(mean/SD) IU/day	45.53/14.96	
Crystalline	3	3.5
(mean/SD) IU/day	10,7/5,13	
Glulisine	8	9.3
(mean/SD) IU/day	18/8.17	
Lispro	2	2.3
(mean/SD) IU/day	14/2.4	

\* Standard Deviation, \*\* Glycated hemoglobin

## 2. Emergency care

The most common clinical manifestations on admission were vertigo (n = 43, 50.0%), adynamia (n = 18, 20.9%), polydipsia (n = 17, 19.8%) and polyuria (n = 9, 10.5%). The mean glycometry value was 416.1mg / dl in 82 patients (95.3%). Table 3 shows the diagnostic aids given to the study patients:

**Table 3.** Paraclinics requested in the study population.

Paraclinical	N	%
<b>Glucometry on admission</b> (<300 /> 300) mg / dL	10/72	12.2/87.8
<b>Blood count</b>	43	50.0
<b>Creatinine</b>	40	46.5
<b>Uroanalysis</b>	40	46.5
<b>Ureic nitrogen</b>	35	40.7
<b>Potassium</b>	11	12.8
<b>Potassium (Average / SD *)</b>	3.8/0.54	
<b>Potassium control</b>	1	9.1
<b>Sodium</b>	9	10.5
<b>Sodium (Mean / SD)</b>	134.8/5.7	
<b>Arterial gases</b>	7	8.1

\* Standard Deviation

Source: Our own elaboration

At the time of discharge, 37 patients (43.0%) received control glucometry (mean: 223mg / dl, SD: 79.2 mg / dL); of these, only 11 (12.7%) had a blood glucose value lower than 180mg / dl. A total of three patients required referral to a tertiary care institution (3.5%). In the follow-up, a total of 16 patients (18.6%) suffered a hyperglycemic crisis again in the first month after discharge, while 40 (46.5%) They presented it in the first six months and nine (22.5%) required hospitalization. Table 4 shows the management with intravenous fluids and insulin received in the emergency department:

**Table 4.** Treatment provided for the management of hyperglycemia in the emergency room.

Variable	N	%
<b>Fluids</b>		
<b>IV Fluids<sup>1</sup></b>	84	97.7
<b>They received bolus of IV fluids</b>	51	59.3
<b>IV fluids infusión</b>	43	50.0
<b>Amount of IV fluids administered (Mean / SD<sup>2</sup>) mL</b>	1276/494	
<b>Insulins</b>		
<b>Received insulin</b>	75	87.2
<b>Single dose of insulin</b>	66	88.0
<b>Venous bolus / subcutaneous application</b>	42/26	56.0/34.7
<b>Insulin infusion</b>	26	34.7
<b>Insulin dose (mean / SD) IU<sup>3</sup> / hour</b>	9.9/8.45	
<b>Hypoglycemia associated with insulin management</b>	2	2.6
<b>Emergency treatment after the crisis</b>		
<b>Received treatment</b>	52	60.5
<b>Basal bolus scheme</b>	24	27.9
<b>Mobile insulin scheme</b>	28	32.55

<sup>1</sup>Endovenous Fluids; <sup>2</sup> SD: standard deviation; <sup>3</sup> IU: international units

### 3. Bivariate analysis

In the unadjusted analysis, it was found that women presented a significant association with a decrease in the probability of presenting a new hyperglycemia in the first month after discharge of emergency care (OR: 0.222, CI: 95%: 0.069–0.716,  $p < 0.008$ ). Additionally, it was found that using insulins prior to emergency care was associated with a higher probability of hospitalization six months after discharge (OR:13.241, 95% CI: 1.575–35.896,  $p < 0.03$ ).

### 4. Multivariate analysis

When performing a logistic regression, no statistically significant associations were found between presenting a new seizure in the first month after discharge from the emergency room with those variables that presented statistical association in the bivariate analyzes.

### Discussion

The present study made it possible to describe the treatment prescribed to patients who consulted for hyperglycemia in the emergency department of a first-level institution, identifying the treatment prior to the consultation and the presentation of new hyperglycemic crises after discharge. It was evidenced that a high proportion of the patients were over the sixth decade of life, data that can be related to what was found in a study carried out in the city of Medellín in 2014 that estimated the prevalence of DM in 12.4% of adults between 60 and 64 years of age (11). According to the World Health Organization (WHO), of all deaths attributable to hyperglycemia, 43.0% occur before the age of 70, with many of these patients being diagnosed late, since the clinical presentation is different from that presented in younger patients (12).

On the other hand, in this research it was found that the majority of patients with hyperglycemia in the emergency room were women (60.5%). According to the WHO, in 2012 the disease ranked eighth among the leading causes of death in both sexes and fifth in women (13). In addition, some risk factors for hyperglycemia have been described, including having high HbA1C, a long-term history of diabetes, being an adolescent, and being a woman (14).

According to the study developed by Rodríguez et al. It was found that 5.9% of the patients with hyperglycemia seen in the emergency room had *de novo* DM (15), a figure that is much lower than that found in this research where 41.9% of the cases did not have a previous diagnosis of the disease, probably associated with difficulties in accessing health services in the city where the study was carried out. This may be due to the inefficiency of public

health programs in charge of identifying patients with chronic noncommunicable diseases, in particular DM or those who are identified as being at risk of suffering it through validated tools such as Finnish Diabetes Risk Score (Findrisc) for Colombia (12). It should be taken into account that in many cases the manifestations are nonspecific (dizziness, asthenia, adynamia), which leads to not suspecting this frequent disease (16-18).

A high percentage of patients were found to have a new hyperglycemia up to one month after discharge from emergency care According to the study by Orozco et al. (19), the rate of non-compliance with the recommendations and therapeutic indications that doctors give their patients with DM is between 30.0 and 51.0% of those who take oral antidiabetics, and about 25.0% with insulins; lack of adherence to medical recommendations reduces options to achieve therapeutic goals, increases the number of visits to the emergency room, hospitalizations, mortality, and is associated with a poor quality of life and a higher cost of health care (19). Likewise, clinical inertia on the part of treating physicians can contribute to the lack of metabolic control and the appearance of acute and chronic complications (20). Therefore, continuous education in health professionals should be reinforced with the implementation of strategies that involve training, updating and sensitization of physicians in the management of DM and other chronic pathologies (18,21).

In the present study, a low proportion of patients were asked for arterial blood gases (despite the availability of this test in the hospital center), an essential evaluation for its classification, therefore, there was not an adequate differentiation of the type of crisis presented, an important condition to define its adequate management (9,22,23,24).

Regarding the mean intravenous fluids administered during emergency department care, the first day was 1276 ml, a low amount compared to the recommendations of the different guidelines (25,26) that suggest administering an average rate of 1000 cc / h during the first 2 - 4 hours, or 15-20 cc / kg / hour, with strict evaluation of the response to management determined clinically according to the improvement in the state of consciousness and with laboratories according to the glucometry tests, the report of electrolytes, pH, bicarbonate, anion gap and osmolarity (14). The initiation of regular insulin in intravenous bolus followed by infusion for one hour until achieving average blood glucose levels lower than 200 mg / dl regardless of the type of hyperglycemic crisis is the current recommendation (27,28). A high proportion of patients received insulin in a single dose (88.0%), and in similar proportions according to the route of administration (venous vs subcutaneous). Currently,

it has been observed that the subcutaneous route is suitable for patients who do not have ketoacidosis or a hyperosmolar state (28,29), orienting that the dose of rapid analog insulins administered by this route during every hour or every two hours are an effective alternative to the intravenous route in terms of resolution of hyperglycemia (28,29).

Regarding the treatment after the crisis, more than 50.0% of the patients received a regimen of mobile doses of insulin, considered less effective than the basal bolus, which reduces the days until glycemic control, reduces hypoglycemia and the days of hospitalization (30-32). In this sense, most of the study subjects were not treated according to the recommendations of clinical practice guidelines (21,23), whose follow-up by doctors has shown a reduction in the time to resolution of hyperglycemia (9.2 vs 13.6 hours) and in the appearance of complications such as septic shock, need for mechanical ventilation and coma (27).

Finally, among the limitations of this study, is the small number of patients included, the impossibility of accurately defining whether the patients had type 1 or type 2 DM based on the clinical history, the origin of the information from the medical history, since the care may not be fully documented — a common situation in observational studies. In addition, the study was carried out in a first level health institution, the majority of the population belonging to the subsidized regime, therefore, the results should be analyzed and applied to similar populations.

In conclusion, a high proportion of patients with hyperglycemia in the emergency room who were unaware of having DM is described. Most of the patients were not requested the necessary paraclinics for an adequate classification of hyperglycemic attacks which evidenced poor adherence to the recommendations of the guidelines for the proper management of these crises in the emergency department. Almost half of the patients consult again for hyperglycemia in the first 6 months after discharge. It is necessary to implement a continuous medical education program that facilitates the appropriation of this type of knowledge in the doctors of the emergency services of this hospital and of others that have similar characteristics.

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### Conflict of interests

The authors of this article declare that they have no conflict of interest.

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