ORIGINAL ARTICLE

Glycemic control in non-critically hospitalized patients in tertiary hospitals in northeast Brazil

Controle glicêmico intra-hospitalar em pacientes não-criticamente enfermos internados em hospitais terciários no nordeste do Brasil

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Abstract

Objective: Inpatient glycemic control is considered an important component of hospital care and patient safety. Nevertheless, its importance in the hospital setting is often underestimated. We aimed to evaluate glycemic control in non-critically hospitalized patients in the state of Ceará, in Northeast Brazil. **Methods**: A cross-sectional study was conducted in three tertiary hospitals in the state of Ceará. We evaluated non-critically ill inpatients, aged 18 years or older, who had hyperglycemia during hospitalization (random plasma glucose > 140 mg/dL or self-reported diabetes mellitus [DM]). **Results**: We evaluated 136 patients (66.2% male, mean age 57.9 ± 16.6 years), 64% of whom had a prior DM diagnosis. Specific nutritional support for DM or hyperglycemia was prescribed for 59.6% of patients. In total, 69.9% of the patients were using insulin. Among them, 47.4% used sliding-scale regular insulin, 18.9% basal-bolus (neutral protamine Hagedorn [NPH] insulin), 28.4% basal-plus (NPH) and 3.1% basal insulin (NPH). The prescriptions given were considered adequate for 26.4% of patients. Of the patients, 69.9% presented blood glucose levels > 180 mg/dL and 29.4% presented levels > 300 mg/dL. Hypoglycemia was observed in 25.7% of patients; protocols for hypoglycemia management were prescribed for 76.5% of them. Education on diabetes during hospitalization was reported by 30.1%. **Conclusion**: The glycemic control regime followed neither national nor international guidelines. These data suggest a need for teams of diabetes specialists in public hospitals in Ceará, working to improve care and following protocols to guide the safety of hospitalized patients.

Keywords: Diabetes Mellitus; Hyperglycemia; Insulin; Patient Safety; Patient Care Team.

Resumo

Objetivo: O controle glicêmico é considerado um componente importante do cuidado hospitalar e da segurança do paciente. Entretanto, sua relevância no contexto hospitalar muitas vezes é subestimada. Nesse estudo, buscamos avaliar o controle glicêmico em pacientes não-críticos internados no estado do Ceará, no Nordeste do Brasil. **Métodos:** Trata-se de um estudo transversal realizado em três hospitais terciários do estado do Ceará. Foram avaliados os pacientes internados nas unidades de enfermaria, com idade acima de 18 anos, que apresentaram hiperglicemia (definida por medida de glicemia plasmática aleatória acima de 140 mg/dL) ou diagnóstico prévio (autorrelato) de diabetes mellitus (DM). **Resultados:** Foram avaliados 136 pacientes (66.2% do sexo masculino, idade média 57.9 ± 16.6 anos), dos quais 64% tinham um diagnóstico prévio de DM. O acompanhamento nutricional específico para DM ou hiperglicemia foi prescrito em 59.6% dos pacientes. No total, 69.9% dos pacientes estavam em uso de insulina. Dentre eles, 47.4% utilizavam insulina regular sob demanda (sliding-scale), 18.9% basal-bolus (insulina NPH), 28.4% basal-plus e 3.1% insulina basal (NPH). As prescrições foram consideradas adequadas para 26.4% dos pacientes. Entre os pacientes analisados, 69.9% apresentaram glicemia capilar > 180 mg/dL e 29.4% apresentaram níveis > 300 mg/dL. Hipoglicemia foi observada em 25.7% dos pacientes e protocolo para hipoglicemia foi prescrito em 76.5% deles. Educação sobre diabetes durante a internação foi realizada em 30.1%. **Conclusão**: O manejo do controle glicêmico não seguiu diretrizes nacionais ou internacionais. Esses dados sugerem a necessidade de uma equipe de especialistas em diabetes em hospitais públicos do Ceará, visando melhorar o cuidado e seguir os protocolos que proporcionam segurança ao paciente internado.

Palavras-chave: Diabetes Mellitus; Insulina; Hiperglicemia; Segurança do Paciente.

INTRODUÇÃO

Hyperglycemia in hospitalized patients has been defined as glycemic elevation (blood glucose level > 140 mg/dL) that occurs in a hospital setting. It may occur 1) in patients with a prior diagnosis of diabetes mellitus (DM) who present with glycemic decompensation; 2) in patients without a prior DM diagnosis who are diagnosed upon admission; and 3) in previously normoglycemic patients who present hyperglycemia only during hospitalization, a condition known as stress hyperglycemia [1,2].

Hyperglycemia aggravates the evolution of coexisting diseases and increases the length of stay, risk of early hospital readmission, cardiovascular, surgical, renal, and infectious complications, and risk of death even in non-critically ill patients[3]. Stress hyperglycemia affects about 10% of the hospitalized population and is associated with a more severe prognosis, increasing the mortality rate to 16% as compared to 3% among diabetic and 1.7% among non-diabetic patients[4,5]. Hypoglycemia increases

morbidity and mortality in diabetics and non-diabetics alike, regardless of the severity[6,7].

The financial impacts of DM on the health system are also increasing and must be borne in mind when formulating healthcare strategies for managing diabetes. In the United States of America (USA), recent data showed that the economic costs of diabetes increased by 26% from 2012 to 2017 due to the increased prevalence of diabetes and cost per patient. This trend is primarily seen in the population aged 65 years and older, contributing to a growing economic cost to the healthcare program[8]. In Brazil, the official database of the Hospital Information System (Sistema de Informação Hospitalar; SIH) of the Unified Health System (Sistema Único de Saúde; SUS) revealed that the hospitalizations attributable to DM between 2008 and 2010 accounted for 8.1%–12.2% of total admissions, representing costs of 10.1%–15.4%. Advanced age was also accompanied by an increase in hospitalization rates and corresponding costs[9].

Considering this evidence, inpatient glycemic control has been considered an important component of hospital care and patient safety[10,11]. In recent years, based on a consensus by specialist societies, certain guidelines for the management of hyperglycemia in hospitalized patients have been proposed, aiming for glycemic targets of 140–180 mg/dL to prevent hypoglycemic episodes[1,2,7]. These guidelines recommend the implementation of institutional clinical protocols and multidisciplinary teams for glycemic control management and encourage continuing education programs involving the entire care team.

Nevertheless, in Brazil, the importance of glycemic control in the hospital setting is often underestimated, especially among non-critically ill patients[12,13]. Therefore, describing the management of this condition in different hospitals across the country is a fundamental requirement for assessing the scenario. This study aimed to evaluate the clinical characteristics and glycemic control of patients hospitalized with hyperglycemia, with or without prior DM diagnosis, in the tertiary hospitals of the state of Ceará, in Northeast Brazil.

METHODS

A cross-sectional study was conducted from July 2017 to June 2018 in three tertiary SUS hospitals in the state of Ceará in Northeast Brazil. The main characteristics of the evaluated hospitals are shown in Table 1.

Data collection

We evaluated randomly selected, non-critically ill inpatients aged 18 years or older, of both genders, who experienced hyperglycemia during hospitalization. Intra-hospital hyperglycemia was defined as having blood glucose levels > 140 mg/dL or having a prior diagnosis of DM (self-reported). The exclusion criteria were a length of stay shorter than 48 hours and admissions limited to the emergency room.

Table 1. Characteristics of the tertiary hospitals of the Unified Health System (SUS) included in the study, Fortaleza - CE (n=136).

	HOSPITAL A (n=41)	HOSPITAL B (n=50)	HOSPITAL C (n=45)
Type	Clinical-surgery	Clinical	Clinical-surgery
Patient profile	Polytrauma	Infectious disease	Heart and lung disease
Medical teaching hospital	Yes	Yes	Yes
Ward beds (n)	319	86	305
Specific institutional protocol for management of hospital glycemic control	No	No	No
Multidisciplinary team to manage glycemic control	No	No	No
Endocrinologist in the clinical staff	Yes	Yes	Yes
Endocrinology ward or unit	No	No	No
Availability of the HbA1c test	No	Irregular	Irregular
% of inpatients with diabetes or hyperglycemia during the study period	11.8%	13.4%	14.7%
Glucometer used for capillary blood glucose monitoring	Accu-check (Roche®)	Accu-check (Roche®)	Accu-check (Roche®)

Abbreviations: HbA1c: glycated hemoglobin.

Data were obtained from medical interviews, prescription analyses, and medical record reviews. The variables evaluated were socio-demographic characteristics, length of stay, glucose monitoring obtained by point-of-care testing (POCT), nutritional support and diet, treatment (oral antidiabetics, insulin prescription, insulin scheme), presence of hypoglycemia (defined by blood glucose level < 70 mg/dL), hypoglycemia management strategy, percentage of patients with blood

glucose level > 180 mg/dL, percentage of patients with blood glucose level > 300 mg/dL, and percentage of patients who received education on DM during hospitalization.

The adequacy of prescriptions regarding glycemic management was also analyzed. Pre-criptions were considered to be inadequate if diet, glucose monitoring, insulin therapy, or hypo-glycemia management protocols were not appropriate for the clinical scenario. The appropriateness of the prescriptions was assessed based on guidelines set by the Brazilian Diabetes Society (2015) (2) and American Diabetes Association (2016) [1].

To calculate prevalence, we visited all non-critical hospital units to survey the number of patients hospitalized with DM or hyperglycemia and the total number of inpatients during the data collection period. The sample size was defined by convenience.

Capillary glucose monitoring

Glucose levels were obtained by POCT, using Accu-Chek (Roche®) glucometers. No routine preventive maintenance was performed for the calibration of glucometers in any of the hospitals chosen for the study; maintenance took place on demand, with corrective maintenance performed only when necessary.

Insulin scheme

The insulin schemes were classified as follows: 1) sliding-scale regular insulin — regular in-sulin on demand according to glycemic levels); 2) basal-bolus regimen — intermediate-acting insulin (NPH) and fixed pre-meal regular insulin; 3) basal-plus regimen — NPH and supplemental regular insulin doses according to the glycemic level; 4) basal regimen — only NPH insulin.

Statistical analyses

Data were analyzed using the Statistical Package of Social Science (SPSS Inc, Chicago, IL, USA), version 15.0 for Windows. Continuous variables were described as mean ± standard deviation and categorical variables as relative and absolute frequencies. For the comparison of categorical variables, the chi-square test or Fisher's exact test was used, and for numerical varia-bles, the Student's t-test or Mann-Whitney test was used.

Ethical aspects

All patients received detailed research instructions and were included in the study only after signing an informed consent form. The project was approved by the Research Ethics Committees of all involved hospitals (Certificate of Presentation for Ethical Assessment – CAAE: 64465816.4.0000.5047). This study was conducted following the recommendations of the Declaration of Helsinki.

RESULTS

A total of 136 patients were evaluated, of whom 90 (66.2%) were male. The mean age was 57.9 ± 16.6 years. Hospitalization time was 19.3 ± 18.6 days. Eighty-seven patients (64%) had a previous diagnosis of DM: 85 (97.7%) of type 2 DM (DM2) and two (2.3%) of type 1 DM (DM1) (self-reported). Forty-nine (36%) patients had no previous DM diagnosis.

Specific nutritional support for DM or hyperglycemia was prescribed for 81 (59.6%) patients. Capillary blood glucose monitoring was performed in 133 (97.8%) patients. For 80 (58.8%) patients, pre-prandial POCTs were performed more frequently four times a day. The number of prescribed and performed POCTs matched in 98 (72.1%) patients.

Regarding therapeutic management, 27 (19.9%) patients had no prescribed treatment (diet, OAD, or insulin) for the management of hyperglycemia, 10 (7.4%) had only diet changes prescribed, 4 (2.9%) were prescribed oral antidiabetic drugs (OAD), 78 (57.3%) were administered insulin, and 17 (12.5%) were prescribed both OAD and insulin. In total, 95 (69.9%) patients used insulin, and among them, 45 (47.4%) used only sliding-scale regular insulin, 18 (18.9%) used basal-bolus (NPH) regimen, 27 (28.4%) used basal-plus (NPH) regimen, and 3 (3.1%) used only basal insulin (NPH).

For 36 (26.4%) patients, the advised prescriptions were considered adequate according to their diagnoses. Among them, blood glucose level > 180 mg/dL was observed in 27 (75%), blood glucose level > 300 mg/dL was seen in 16 (44.4%), and hypoglycemia (blood glucose level < 70 mg/dL) was seen in 15 (41.7%) patients.

Among patients with blood glucose level > 180 mg/dL, 22 (22.9%) did not use insulin and 29 (30.2%) used only sliding-scale regular insulin. In the group of patients with blood glucose levels > 300 mg/dL, three (7.5%) did not use insulin and nine (22.5%) used only sliding-scale regular insulin.

Regarding glycemic control, 95 (69.9%) patients presented with blood glucose levels > 180 mg/dL and 40 (29.4%) with blood glucose levels > 300 mg/dL. Hypoglycemia was observed in 35 (25.7%) patients, and hypoglycemia management was prescribed for 101 (76.5%) patients. Only eight (5.8%) patients had A1c levels entered in their medical records.

Education on DM during hospitalization was reported by 41 (30.1%) patients. There was no continuing education program about hyperglycemia or diabetes in most cases. Glycemic control management strategies differed between patients with previously diagnosed DM and those without, especially regarding dietary support, pharmacological treatment, insulin scheme, glucose levels, and prescription adequacy (Table 2). The description of characteristics related to glycemic control in each hospital is given in Table 3.

Table 2. Glycemic control management in previously diagnosed diabetes and no previously diagnosed diabetes patients, Fortaleza - CE (n=136).

	Previous DM (n=87)	No previous DM (n=49)	p-value
Age (years); mean ± SD)	61.7 ± 15.1	51.1 ± 17.1	< 0.001
Male %; (n)	66.7; (58)	65.3; (32)	0.872
No treatment %; (n)	1.1; (1)	53.1; (26)	< 0.001
Diet %; (n)	81.6%; (71)	20.4; (10)	< 0.001
Insulin %; (n)	88.5; (77)	36.7; (18)	0.001
Oral anti-diabetic %; (n)	21.8; (19)	4.1; (2)	0.006
Sliding-scale scheme %; (n)	37.9; (33)	24.5; (12)	0.110
Basal-bolus %; (n)	18.4; (16)	4.1; (2)	0.018
Basal-plus %; (n)	28.7; (25)	4.1; (2)	< 0.001
Hypoglycemia %; (n)	27.6; (24)	22.4; (11)	0.511
Glu > 180 mg/dL %; (n)	83.9; (73)	44.9; (22)	< 0.001
Glu > 300 mg/dL %; (n)	43.7; (38)	4.1; (2)	< 0.001
Hypoglycemia protocol %; (n)	75.9; (66)	77.6; (38)	0.824
Education in DM %; (n)	34.5; (30)	22.4; (11)	0.142
Preprandial monitoring (4x) %; (n)	57.5; (50)	61.2; (30)	1.000
Agreement monitoring %; (n)	67.8; (59)	79.6; (39)	0.142
Appropriate management %; (n)	34.5; (30)	12.2; (6)	0.005

Abbreviations: SD: standard deviation; Glu: capilar glucose; DM: diabetes mellitus. Significant p-value if < 0.05.

Table 3. Glycemic control per hospital, Fortaleza – CE (n=136)

	HOSPITAL A n=41	HOSPITAL B n=50	HOSPITAL C n=45
Age (years); mean ± SD)	64.3 ± 17.8	49.8 ± 15.1	61.0 ± 13.5
Male %; (n)	63.4; (26)	74.0; (37)	60.0; (27)
Previous DM %; (n)	80.5; (33)	48.0 (24)	66.7; (30)
No treatment %; (n)	4.9; (2)	28.0 (14)	24.4; (11)
Diet %; (n)	75.6; (31)	40.0 (20)	66.7; (30)
Insulin %; (n)	90.2; (37)	62.0 (31)	60.0; (27)
Oral anti-diabetic %; (n)	12.2; (5)	12.0 (6)	22.2; (10)
Sliding-scale scheme %; (n)	56.7; (21)	35.5; (11)	48.1; (13)
Basal-bolus regimen %; (n)	18.9; (7)	12.9; (4)	25.9; (7)
Basal-plus regimen %; (n)	21.6; (8)	38.7; (12)	25.9; (7)
Basal regimen %; (n)	2.7; (1)	12.9; (4)	0
Hypoglycemia %; (n)	17.1; (7)	18; (14)	31.1; (14)
Glu > 180 mg/dL %; (n)	70.7; (29)	76.0; (38)	62.2; (28)
Glu > 300 mg/dL %; (n)	22.0; (9)	32.0; (16)	33.3; (15)
Hypoglycemia protocol %; (n)	70.7; (29)	78.0; (39)	80.0; (36)
Education in DM %; (n)	24.4; (10)	12.0; (6)	55.6; (25)
Preprandial monitoring (4x) %; (n)	53.7; (22)	52.0; (26)	71.1; (32)
Agreement monitoring %; (n)	26.8; (11)	24.0; (12)	33.3; (15)
Appropriate management %; (n)	24.4; (10)	22.0; (11)	33.3; (15)

Abbreviations: SD: standard deviation; Glu: capilar glucose; DM: diabetes mellitus. Significant p-value if < 0.05.

DISCUSSION

In this study, the main parameters related to glycemic control in hospitalized patients were assessed in three large referral hospitals in the state of Ceará, Brazil. Our data showed that the management of hyperglycemia differs from the evidence-based protocols for in-hospital glycemic control recommended by societies of diabetes specialists.

Only a quarter of the patients had adequate prescriptions, and among them, satisfactory glycemic control had not been achieved in many patients, with POCTs persistently above the recommended glycemic target, between 140 and 180 mg/dL. The main form of treatment for hyperglycemia was the use of sliding-scale regular insulin, contradicting established guidelines on hospital glycemic control, which recommend basal-bolus or basal-plus insulin regimens as therapies of choice and discourage the isolated use of rapid insulin in titrated doses[1,2,7].

This problem was exacerbated in patients with hyperglycemia and no previous DM diagnosis. Among them, only a minority (12%) had prescriptions appropriate in the clinical context. In addition to inadequate pharmacological management, including more frequent use of sliding-scale regular insulin, we also observed recurrent omissions of nutritional assessment and dietary treatment.

Regarding hypoglycemia, we demonstrated that approximately 25% of patients had hypo-glycemia at some point during their stay in the hospital. Literature indicates that hypoglycemia is one of the most frequent complications seen in a hospital setting. Prevalence of hypoglycemia (< 70 mg/dL) ranges from 3% to 30% based on different studies assessing medical and surgical patients with DM2[12-15]. This issue could be immediately addressed by instituting standardized hospital-wide, nurse-initiated hypoglycemia treatment protocols[6]. However, in approximately a third of the patients, no hypoglycemia treatment protocol had been prescribed to guide the nursing team.

Another relevant finding of this study was the absence of diabetes education measures for hospitalized patients with hyperglycemia. Less than a third of the patients received guidance regarding DM during hospitalization, and this number was lower among hyperglycemic patients without a prior DM diagnosis. Hospitalization is considered to be an opportune and valuable time for educating patients with DM[7]. It has been recommended that, for appropriate levels of patient education, the main contents related to diabetes be reviewed and addressed prior to hospital discharge[1,2]. Patients with stress hyperglycemia should also receive guidance regarding the need for follow-up after hospital discharge due to the higher risk of developing DM[16].

Overall, our results were similar to those of other studies on in-hospital glycemic control, including a cross-sectional survey (n = 2,399) performed between 2010 and 2012 in 24 hospitals located in 13 cities from all five Brazilian regions. In this large, representative study, the proportion of patients with hyper- and hypoglycemia and the pharmacological treatments used were similar to those in our study. The researchers showed POCT > 180 mg/dL in 89.4% of patients and POCT < 70 mg/dL in 30.9% of the patients. Half of the cases were treated with a sliding-scale insulin regimen alone (52.0%), and only 35.7% received the appropriate type of insulin therapy (basal + bolus insulin)[12].

Findings such as those described above, as well as our own, indicate that there is space for improvement in the management of patients with hyperglycemia in our hospitals. Several different strategies can be adopted to address these deficiencies, such as screening for hyperglycemia or DM upon admission, identification of patients with DM or hyperglycemia through wrist/bed tags, use of software or electronic medical records that tag patients at risk of hypoglycemia or hy-perglycemia for the attention of healthcare professionals, multi-professional staff training, implementation of protocols using intravenous or subcutaneous insulin for the preoperative preparation of patients with DM, and diabetes education for patients during hospitalization[6,7,10,11,17]. The creation of specific teams for hospital glycemic control can contribute to this process, though their active participation in the planning, implementation, and follow-up of such improvement measures is vital for a successful outcome[2,18].

In this regard, a recent national study has shown encouraging results. Momesso et al. published a study conducted between 2014 and 2017 to describe and evaluate the impact of the implementation of an inpatient multidisciplinary glucose control management program in a hospital in Rio de Janeiro, Brazil (18). Implementation of the program led to significant reductions in hyperglycemic events. The key contributing elements were the development of institutional inpatient glycemic control protocols, the establishment of a multidisciplinary team, and continuous educational programs for hospital personnel.

In developed countries such as the USA, this movement is already more advanced. Since the early 2000s[6,10,11,19-22], different centers in the country have been mobilized to undertake the implementation of protocols for optimal management of glycemic control in hospitals. This has resulted in improvements in the care of hospitalized diabetic patients. In Brazil, such programs are still in very early phases and have not been fully rolled out. While there are specific initiatives, they are scarce with respect to the size of the country.

Thus, further studies in this area would be very helpful, especially considering the deficiency of beds in tertiary hospitals and the limitations related to health care costs in Brazil. Better understanding and management of this high morbidity condition may have a positive impact on bed availability, allowing for reduced health costs, ultimately benefiting both patients and the healthcare system.

Finally, despite its relevance, our study has some limitations. We did not have A1c levels for most patients to differentiate between those with newly diagnosed DM and those with stress hyperglycemia. Due to the cross-sectional design of our study, we did not monitor patients until discharge, preventing us from evaluating other outcomes such as the length of stay, readmission rate after discharge, and mortality rate. We also did not assess whether there was a change in the medical prescription guided by POCTs obtained on the previous day.

The major strength of our study was that it described the care related to diabetes in three major referral hospitals in our state, demonstrating the need to adhere to recommendations proposed by medical societies specifically dealing with diabetes. Studies such as this would arouse the interest of health managers, enabling them to familiarize themselves with the local reality of these institutions and facilitate decision-making processes in order to overcome possible barriers preventing adherence to recommended standards and optimal diabetes care.

In conclusion, due to heterogeneity in the diagnosis and management of hyperglycemia in hospitalized patients, glycemic control paradigms did not follow national or international norms. The implementation of teams of diabetes specialists, similar to those already existing in developed countries, could optimize this process, improving assistance and allowing adherence to guidelines for the safety of patients. These teams could act as facilitators for the implementation of institutional protocols and continuous education programs in SUS public hospitals.

FUNDING

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