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Evaluating Hospital Revisit Risk in Patients Discharged from the Emergency Department with Blood Glucose of 300 mg/dL (16.7 mmol/L) or Greater

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Abstract: Background: In the emergency department (ED), hyperglycemia may be overlooked due to non-diabetes mellitus (DM) primary diagnoses. We compared the risk of all-cause hospital revisits within 30 days after ED discharge in DM patients with normal blood glucose (BG), moderate hyperglycemia, and severe hyperglycemia. Methods: This was a retrospective cohort study of patients 18 years and older discharged from a tertiary care ED between 1 January and 31 March 2018. The severe hyperglycemia group had BG levels of 300 mg/dL (16.7 mmol/L) or greater. The moderate hyperglycemia group had a history of DM, all BG levels less than 300 mg/dL (16.7 mmol/L), and at least one BG level of 180 mg/dL (10 mmol/L) or greater. The normal BG group had a history of DM and BG less than 180 mg/dL (10 mmol/L). Results: Of 302 patients who met criteria, 118 had severe hyperglycemia, 67 had moderate hyperglycemia, and 117 had normal BG. No significant difference between the severe hyperglycemia, moderate hyperglycemia, and normal BG groups was found in 30-day all-cause hospital revisits (19.5% vs. 10.4% vs. 15.4%, respectively, $p = 0.25$). Patients with a past medical history (PMH) of atherosclerotic cardiovascular disease (ASCVD) or any ED visit in the year preceding the index visit each had an increased risk of a hospital revisit within 30 days ($p = 0.025$) after covariate adjustment; the adjusted risk of a 30-day hospital revisit among those with a PMH of ASCVD was 2.68 times greater than the risk among those without a history of ASCVD (95% CI: 1.59 to 4.53), and the adjusted RR of a 30-day revisit among those who had an ED visit in the prior year was 1.92 times greater than those without an ED visit in the prior year (95% CI: 1.10 to 3.35). Conclusions: The results suggest no significant association between hyperglycemia in the ED and 30-day hospital revisits. In any patient with DM with a history of ASCVD or any ED visit in the previous year, there may be an increased risk of revisits.

Keywords: emergency hospital service; hyperglycemia; hospital readmission; patient discharge; blood glucose; retrospective studies

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1. Introduction

Patients with diabetes mellitus (DM) account for over 14 million emergency department (ED) visits yearly [1]. It has been reported that if an ED patient with hyperglycemia presents with a primary concern unrelated to hyperglycemia, the primary diagnosis can overshadow the elevated blood glucose (BG) [2]. The primary reason for the ED visit (e.g.,

infection) could also be contributory towards hyperglycemia. These patients are commonly discharged straight from the ED once their chief complaint has been addressed. Often, the patient may not be informed of their hyperglycemia and/or provided with necessary outpatient referrals [2]. Random elevated BG values in the ED have been found to correlate with elevated hemoglobin A1c (HbA1c) [3]. In patients in an ED observation unit (EDOU) with BG levels $\geq$ 300 mg/dL (16.7 mmol/L), the mean HbA1c was 12.1% $\pm$ 2.2% [3,4]. Because severe BG elevations are indicative of uncontrolled DM, failing to appropriately address this issue is a public health concern. Currently, however, there is no clear consensus or guideline for patients discharged from the ED with hyperglycemia [5].

A retrospective study conducted by Driver et al. looked to describe short-term outcomes for adult patients with type 2 DM discharged from the ED with any BG value $\geq$ 400 mg/dL (22.2 mmol/L). Outcomes of interest focused on repeat ED visits for hyperglycemia, diabetic ketoacidosis (DKA), hyperosmolar hyperglycemic state (HHS), and hospitalization for any reason. In the 7-day follow-up period, no association was found between the discharge BG level and repeat ED visits for hyperglycemia or hospitalization for any reason [5]. A subsequent prospective, randomized trial by Driver et al. looked at ED length of stay and 7-day outcomes for patients discharged from the ED with a BG level less than 350 mg/dL (19.4 mmol/L) or less than 600 mg/dL (33.3 mmol/L) but found no significant difference between the two groups [6]. The limitation of these two studies is the short follow-up period of 7 days. A 2023 observational study conducted by Gunsoy et al. examined the rate of and factors influencing hospitalization and ED revisits 7 and 30 days after an index ED visit for hyperglycemia not complicated by hyperglycemic crisis [7]. The authors concluded that ED revisits and hospitalizations were not increased at 7 or 30 days regardless of age, gender, the type of diabetes, or the initial ED blood glucose level. They did suggest that having "insulin dependent diabetes" was a positive predictor for revisits and hospitalization by 7 days and revisits alone by 30 days. The inclusion criteria for this last cohort of patients was not qualified by the authors, however. Lastly, a retrospective study conducted by Yan et al. looked at ED patients (though only about half of whom were discharged home from the ED) with a discharge diagnosis of hyperglycemia, DKA, or HHS. They had found that a previous hyperglycemia visit in the past month, age less than 25 years, glucose greater than 20 mmol/L (360 mg/dL), and insulin use were among the risk factors for unplanned recurrent ED visits for hyperglycemia within 30 days [8,9].

To differentiate from existing studies, our study compared three groups of varying glucose levels among adult ED patients over a follow-up period of 1 year and sought to determine if higher glucose levels are associated with an increased likelihood of revisits.

2. Materials and Methods

2.1. Study Setting and Population

Long Island Jewish Medical Center (LIJMC) is a tertiary care teaching hospital in Queens, NY, and part of Northwell Health, which was made up of 19 hospitals throughout the New York Metropolitan area during the study period [10]. LIJMC's emergency department has over 100,000 visits annually [11]. This was a retrospective cohort study evaluating all patients 18 years and older discharged from the ED of an academic tertiary care center between 1 January 2018 through 31 March 2018, with (1) a BG level $\geq$ 300 mg/dL (16.7 mmol/L) (severe hyperglycemia), (2) a PMH of DM (or HbA1c $\geq$ 6.5%), all BG levels less than 300 mg/dL (16.7 mmol/L) and at least one BG $\geq$ 180 mg/dL (10 mmol/L) (moderate hyperglycemia), and (3) a PMH of DM (or HbA1c $\geq$ 6.5%), and all BG levels less than 180 mg/dL (10 mmol/L) during the visit (normal BG). A cutoff of 300 mg/dL (16.7 mmol/L) was chosen for the severe hyperglycemia group, as the early initiation of insulin therapy is recommended in patients with type 2 DM with a random BG level that is $\geq$300 mg/dL (16.7 mmol/L) [12].

2.2. Study Protocol

Data were pulled electronically by an independent information technology (IT) team based on pre-specified criteria. Additional clinical information was accessed using medical records 1 year prior to the index visit and 1 year after the index ED visit (e.g., from 1 January 2017 to 1 January 2019 or from 31 March 2017 to 31 March 2019). Records were taken from encounters within the health system. This study was determined to be exempt from approval by the health system's Institutional Review Board.

Patients were excluded if their index reason for visit was hypoglycemia, or if, at the time of the index visit, they had any serum or point-of-care BG level less than 70 mg/dL (3.89 mmol/L), expired, were admitted to the hospital or the EDOU, left against medical advice, were pregnant, or received dextrose 50% or corticosteroids pre-hospital or in the ED.

2.3. Key Outcome Measures

The primary objective was to evaluate the risk of all-cause hospital revisits within 30 days in patients with severe hyperglycemia discharged from the ED compared to patients with DM having moderate hyperglycemia or normal glucose levels in the ED. Secondary objectives were to compare the 60-day, 90-day, and 1-year all-cause hospital revisit risk between cohorts and to compare extended major adverse cardiovascular event (MACE) outcomes at 1-year revisits between cohorts.

2.4. Statistical Analysis

For all aims, descriptive statistics (e.g., frequencies and proportions for categorical variables and medians and the interquartile range for continuous factors, such as patient gender and the duration of index ED visits, respectively) were computed for the sample overall and for each cohort. The definition of hospital revisits included emergency department visits, observational stays, and/or inpatient readmissions. To evaluate the risk of hospital revisits between cohorts, log binomial regression was used to determine if there is an association between the status of BG values (normal, moderate hyperglycemia, or severe hyperglycemia) and the risk of hospital revisits within 30 days, 60 days, 90 days, and 1 year (modeling each endpoint separately).

Multivariable regression was performed for 30-day risk, 90-day risk, and 1-year risk outcomes, to adjust for potential confounders as appropriate. Factors associated with the univariate analysis at the $p < 0.1$ level were considered for inclusion in the respective multivariable model. Factors evaluated included gender, age, race, ethnicity, a past medical history of hypertension, hyperlipidemia, or atherosclerotic cardiovascular disease, antidiabetic medication regimen initiations or modifications addressed in the ED or discharge note for the index visit status, diabetes education addressed in the ED or discharge note for the index visit status, glucose-related index reasons for the visit (DKA, HHS, etc.) status, insurance, the status of ED visits previously, weekend visits, time shifts, and any blood glucose greater than or equal to 300 mg/dL (16.7 mmol/L) within the prior year. Multicollinearity was assessed before entering covariates into the model. Backward elimination using an alpha level of 0.05 was used to select the final model for each outcome while keeping the cohort status in the model. The relative risk (RR) or risk ratio and associated 95% confidence intervals (CIs) were computed as appropriate.

Extended MACEs, defined as cardiovascular death, non-fatal myocardial infarction, non-fatal stroke, hospitalization for heart failure, hospitalization for unstable angina, and hospitalization for revascularization [13] were modeled as a composite endpoint and analyzed using Fisher's exact tests due to its rare event rate, along with a computation of the RR with a corresponding 95% CI (for the risk of any MACE over the course of a 1-year follow up among all subjects). All multiple pairwise comparisons (i.e., comparisons of the 90-day risk of hospital revisits among the three cohorts) were adjusted using Bonferroni-correction methods to control the overall type I error rate. However, no adjustment was made for assessing multiple endpoints due to the exploratory nature of this study. For

all analyses, a result yielding a p-value < 0.05 was considered statistically significant. All analyses were conducted using SAS version 9.4 (SAS Institute Inc., Cary, NC, USA).

3. Results

Four-hundred and thirty-nine patient charts were reviewed for inclusion in this study, of which 302 patients met the eligibility criteria. Common reasons for exclusion included hospital admission (32%, n = 44), hypoglycemia (17.5%, n = 24), and steroid use (11.7%, n = 16). Twenty-nine percent of the exclusions were revisits of patients who were already included in this study (n = 40). One-hundred and eighteen patients (39%) were categorized as having severe hyperglycemia, 67 (22%) had moderate hyperglycemia, and 117 (39%) had normal BG levels (Figure 1). Within the same prespecified time period, there were 219 EDOU admissions that were not included (severe hyperglycemia = 58, moderate hyperglycemia = 81, normal glucose = 80).

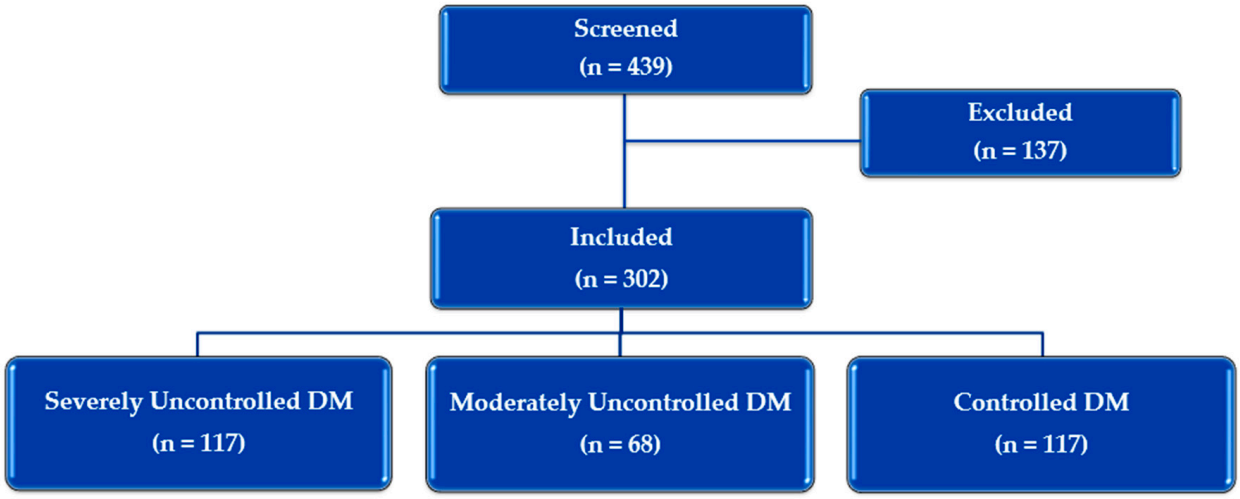

Figure 1. Enrollment.

Age, gender, and PMH were comparable between groups (Table 1). Significant differences between the groups were found regarding race, insurance, hyperglycemia-related reasons for the ED visit, and history of ED visits in the prior year. Forty-five percent (n = 53) of the patients in the severe hyperglycemia group were African American, and the majority of patients in this group were on Medicare and/or Medicaid (92.3%, n = 109). There were more patients in the severe hyperglycemia group with a hyperglycemia-related reason for the visit compared to the moderate hyperglycemia and normal BG groups (29.7% vs. 6.0% vs. 0.9%, respectively, $p < 0.0001$). There were also significantly more patients in the severe hyperglycemia group compared to the moderate hyperglycemia and normal BG groups with an ED visit in the prior year (39.0% vs. 9.0% vs. 15.3%, respectively, $p < 0.0001$). Only 24 of 302 patients (8%) in our cohort of patients discharged directly from the ED had their HbA1c drawn in the ED prior to discharge. The vast majority of patients had a known PMH of DM, with only 4 of 302 patients (1.3%) having new-onset DM. Additionally, about 70% of patients in each cohort did not have a type of diabetes specified (e.g., "DM"). Patient demographics according to cohort status are listed in Table 1. As exploratory endpoints, it was found that 1.7% of patients in the severe hyperglycemia cohort had an endocrine consult, 8.5% had an initiation of or modifications to their DM regimen upon discharge, and 22% had DM education addressed in their ED note or discharge note.

Table 1. Baseline characteristics.

	Severe Hyperglycemia (n = 118)	**Moderate Hyperglycemia (n = 67)**	**Normal BG (n = 117)**	***p*-Value**
Mean age, years (SD)	55.4 (16.5)	56.4 (15.6)	58 (14)	$p = 0.6939$
Male, n (%)	56 (47.5)	36 (53.7)	57 (48.7)	$p = 0.7039$
Race, n (%)				
African American or Black	53 (44.9)	18 (26.9)	43 (36.8)	$p = 0.0232$
White	13 (11)	9 (13.4)	19 (16.2)	
Asian	20 (16.95)	25 (37.3)	25 (21.4)	
Other or Multiracial	30 (25.4)	11 (16.4)	23 (19.7)	
Insurance, n (%)				
Medicare	47 (39.8)	14 (20.9)	34 (29)	$p = 0.0008$
Medicaid ^	62 (52.5)	28 (41.8)	45 (38.5)	
Uninsured/Self-pay	8 (6.8)	3 (4.5)	17 (14.5)	
Private/Commercial	29 (24.6)	29 (43.3)	39 (33.3)	
Hyperglycemia-related Reason for Visit, n (%)	35 (29.7)	4 (5.97)	1 (0.9)	$p < 0.0001$
ED Visit in Prior Year, n (%)	46 (39)	6 (9.0)	18 (15.3)	$p < 0.0001$
HbA1c, %, Mean (SD)	12.5 * (1.76)	10 † (1.24)	6.9 ‡	-
Known PMH DM, n (%)	115 (97.5)	66 (98.5)	117 (100)	-
DM classification, n (%)				
Type 1	9 (7.6)	3 (4.5)	2 (1.7)	-
Type 2	28 (23.7)	16 (23.9)	26 (22.2)	
Unspecified ("DM only")	79 (67)	48 (71.6)	89 (76.1)	
Maximum BG, mean (SD)	401 (89.1)	231 (32.4)	135 (26.4)	$p < 0.0001$
Arrival BG, mean (SD)	385 (86.1)	222 (35.2)	131 (27)	$p < 0.0001$
Discharge BG, mean (SD)	290 (73.1)	214 (40.3)	128 (25.6)	$p < 0.0001$
Smoking Status, n (%) ^^				
Current	11 (9.3)	3 (4.5)	12 (10.3)	-
Former	7 (5.9)	1 (1.5)	10 (8.5)	
Never	70 (59.3)	48 (71.6)	77 (65.8)	
Pertinent PMH, n (%)				
Hypertension	74 (62.7)	40 (59.7)	79 (67.5)	$p = 0.5354$
Hyperlipidemia	41 (34.8)	21 (31.3)	42 (35.9)	$p = 0.8189$
ASCVD	21 (17.8)	10 (14.9)	11 (9.4)	$p = 0.1710$
Chronic Kidney Disease	4 (3.4)	0 (0)	4 (3.4)	$p = 0.37$
Obesity or BMI ≥ 30 kg/m^2	8 (6.8)	1 (1.5)	12 (10.3)	$p = 0.08$

ASCVD = atherosclerotic cardiovascular disease, BG = blood glucose, BMI = body mass index, DM = diabetes mellitus, PMH = past medical history, SD = standard deviation. ^ Medicaid and managed medicaid combined for the purposes of this table though statistical analysis conducted separately. ^^ No *p*-value because 26% in the severe hyperglycemia cohort are unknown, 22% in the moderate hyperglycemia cohort are unknown, and 15% in the normal BG cohort are unknown.* n = 18, † n = 5, ‡ n = 1.

For the primary outcome of 30-day hospital revisits, a total of 48 (16%) patients had a revisit within 30 days—23 (19.5%) in the severe hyperglycemia cohort, 7 (10.4%) in the moderate hyperglycemia cohort, and 18 (15.4%) in the normal BG cohort. However, these

differences were not found to be significantly different (p = 0.25) in the univariate analysis (Figure 2). The unadjusted RR comparing the 30-day risk of hospital revisits among the severe hyperglycemia group to the moderate hyperglycemia group was 1.87 (95% CI, 0.85 to 4.12, p = 0.12), and the severe hyperglycemia group to the normal BG group was 1.27 (95% CI, 0.72 to 2.22, p = 0.41) (Table 2). Further, after adjusting for the past medical history (PMH) of Atherosclerotic CVD (ASCVD), defined as acute coronary syndromes, a history of myocardial infarction, stable or unstable angina, coronary or other arterial revascularization, stroke, transient ischemic attack, or peripheral arterial disease presumed to be of atherosclerotic origin and status of having an ED visit in the year prior to current index visit (p = 0.001 and p = 0.025, respectively), there was no significant evidence that the 30-day hospital revisit risk was different among the three cohorts (p = 0.48). There was evidence of a significant increased risk of 30-day hospital revisits among those with a PMH of ASCVD or an ED visit in the year prior to the current index visit in the adjusted analysis. Specifically, the risk of 30-day hospital revisits among those with a PMH of ASCVD was 2.68 times greater than the risk among those without a history of ASCVD, after adjusting for the other factors in the model (95% CI: 1.59 to 4.53). The adjusted RR of a 30-day revisit among those who had an ED visit in the prior year was 1.92 times greater than those without an ED visit in the prior year (95% CI: 1.10 to 3.35). Of the patients with a revisit within 30 days, 21.7% in the severe hyperglycemia group and 28.6% in the moderate hyperglycemia group had a visit reason related to hyperglycemia. There were no revisits related to hyperglycemia in the normal BG group.

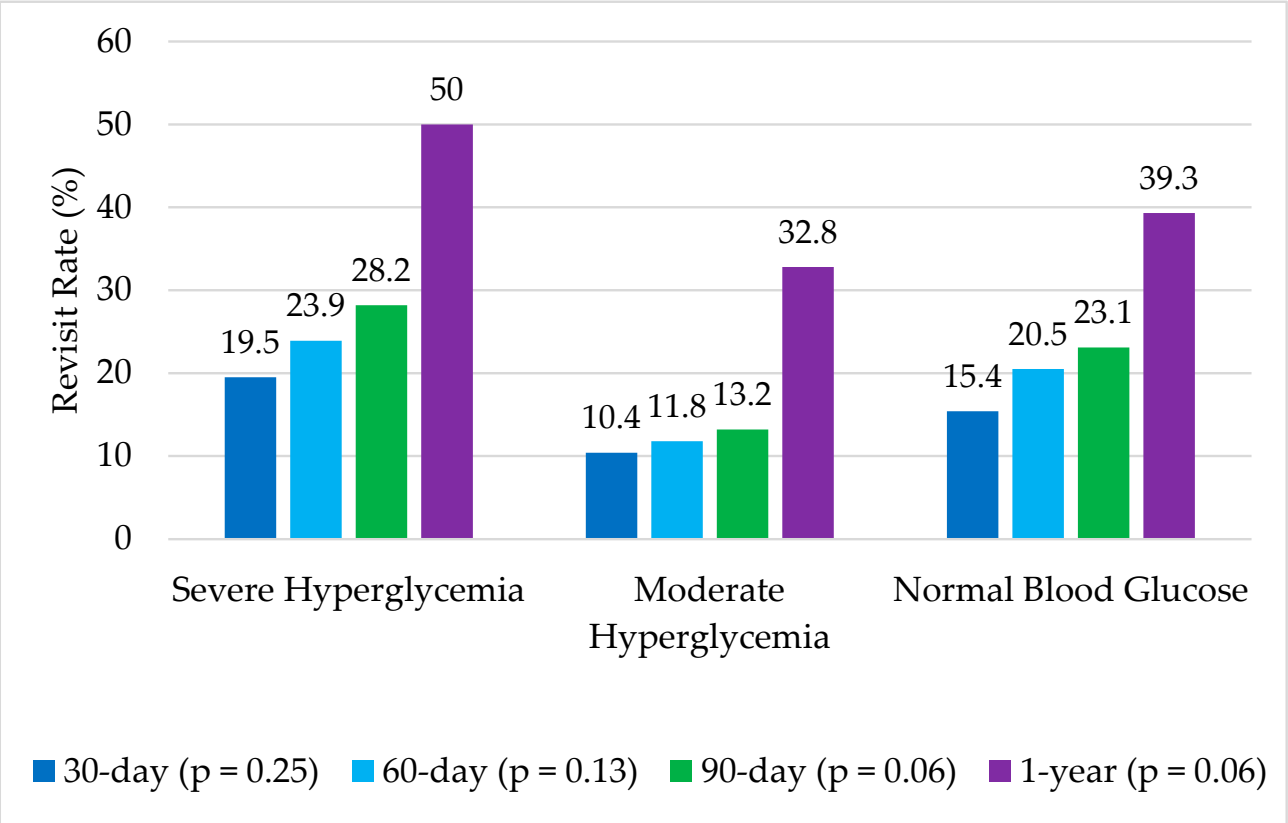

Figure 2. Primary and secondary endpoints: all-cause hospital revisits.

Table 2. Risk of all-cause hospital/ED revisits by hyperglycemia status.

	30-Day Revisit	30-Day Revisit	60-Day Revisit	60-Day Revisit	90-Day Revisit	90-Day Revisit	1-Year Revisit	1-Year Revisit
	RR (95% CI)	*p*-Value	RR (95% CI)	*p*-Value	RR (95% CI)	*p*-Value	RR (95% CI)	*p*-Value
Severe Hyperglycemia vs. Moderate Hyperglycemia	1.87 (0.85–4.12)	0.12	1.99 (0.96–4.11)	0.06	2.08 (1.06–4.08)	0.03 *	1.52 (1.03–2.24)	0.03 *
Severe Hyperglycemia vs. Normal Blood Glucose	1.27 (0.72–2.22)	0.41	1.15 (0.72–1.87)	0.55	1.21 (0.78–1.88)	0.39	1.27 (0.95–1.70)	0.1

BG = blood glucose, CI = confidence interval, RR = risk ratio. *: Pairwise comparisons were not significant using Bonferroni-corrected *p*-value (adjusted alpha = 0.0167).

For the secondary outcomes, though the all-cause hospital revisit rate in the severe hyperglycemia group was observed to be numerically greater than the moderate hyperglycemia or normal BG groups at 60 days, 90 days, and 1 year, the adjusted risk of any of these endpoints was not found to be statistically significant between the groups (Table 2, Figure 2). Though univariately, there appears to be a significant difference in the risk for revisits within 90 days and 1 year between severe hyperglycemia and moderate hyperglycemia, this finding was no longer statistically significant after adjusting the *p*-value (due to increased type 1 error rate from performing multiple pairwise comparisons). Similar to the results from the 30-day hospital revisit analysis, the multivariable model for the 90-day risk included a history of ASCVD and any ED visit in the year prior to the index visit ($p = 0.0035$ and $p = 0.0006$, respectively) in addition to the degree of hyperglycemia ($p = 0.29$). Subjects with a PMH of ASCVD or an ED visit in the year prior to the index visit had an increased risk of hospital revisits at 90 days regardless of the BG cohort. Specifically, the risk of a 90-day hospital revisit among those with a PMH of ASCVD was 2.02 times greater than the risk among those without a history of ASCVD, after adjusting for the other factors in the model (95% CI: 1.32 to 3.10). The adjusted RR of a 90-day revisit among those who had an ED visit in the prior year was 2.19 times the risk among those without an ED visit in the prior year (95% CI: 1.42 to 3.40). The final multivariable log binomial regression model that evaluated the risk of revisits within 1 year as a function of the cohort group ($p = 0.77$) adjusted for any ED visit in prior year and a PMH of hypertension ($p = 0.0003$ and $p = 0.0345$, respectively). The adjusted risk of a 1-year revisit among those who had an ED visit in the prior year was 1.69 times greater than those without any ED visits in the prior year (95% CI: 1.28 to 2.22). The risk ratio of hospital revisits within 1 year among those with a PMH of hypertension was 1.38 times greater than the risk among those without a history of hypertension, after adjusting for the other factors in the model (95% CI: 1.00 to 1.89).

In terms of a breakdown of reasons for revisits among 127 patients across the cohorts over the one-year follow-up period, hyperglycemia was the cause in 9.4% (32/339 of total revisits since patients often had multiple revisits). Other revisit reasons were related to infection (65/339 = 19.2%), pain (41/339 = 12.1%), cardiovascular (36/339 = 10.6%), gastrointestinal (36/339 = 10.6%), psychiatric (24/339 = 7.1%), respiratory (11/339 = 3.2%), and other (94/339 = 27.7%).

Eight (6.3%) subjects experienced a MACE outcome in their first revisit (out of the 127 with any revisit); 16 (12.6%) experienced a MACE during any hospital revisit within the first year post-initial study visit. Table 3 includes the rates of MACEs on first revisit and on any revisit (of those with any revisit) for the normal glucose, moderate hyperglycemia, and severe hyperglycemia cohorts. Table 4 illustrates that the risk of a MACE during the first year following the index visit is not significantly different when comparing severe hyperglycemia to moderate ($p = 0.16$) or severe to normal ($p > 0.99$).

Table 3. Extended MACE outcomes across cohorts.

	All Patients	Normal BG	Moderate Hyperglycemia	Severe Hyperglycemia
First revisit	8/127 (6.3%)	2/46 (4.3%)	0/22 (0.0%)	6/59 (10.2%)
Any revisit	16/127 (12.6%)	7/46 (15.2%)	1/22 (4.6%)	8/59 (13.6%)

MACE = major adverse cardiovascular event, BG = blood glucose.

Table 4. Risk of a MACE within first year of index visit.

	RR (95% CI)	*p*-Value
Severe Hyperglycemia vs. Moderate Hyperglycemia	4.54 (0.58–35.54)	0.16
Severe Hyperglycemia vs. Normal Blood Glucose	1.13 (0.42–3.02)	>0.99

MACE = major adverse cardiovascular event, RR = risk ratio, CI = confidence interval.

4. Discussion

The results of this study found no significant associations between varying BG levels in the ED and all-cause hospital revisits. While counterintuitive, this finding might suggest that there is no additional harm in discharging a patient straight home from the ED with a BG level (at any point in their ED stay) $\geq$ 300 mg/dL (16.7 mmol/L) if no other reason for observation or admission is identified. This outcome is consistent with the existing literature that also did not find an association between discharge BG and repeat ED visits or hospitalization within 7 days (both related and unrelated to hyperglycemia) [5,6]. In our study, approximately one-fifth of the patients in the severe hyperglycemia group and one-quarter of the patients in the moderate hyperglycemia group with revisits had a hyperglycemia-related hospital revisit within 30 days, while no patients in the normal BG group had a hyperglycemia-related visit. On the other hand, our results may also simply show that the current ED workflow at our institution is effective at admitting higher risk patients to a higher level of care, such as the EDOU [4,14], and discharging patients who are not as high risk. This effect may make the results harder to apply to other institutions who do not have the same ED and EDOU workflow.

Currently, all patients in our institution's EDOU have HbA1c labs drawn, and those who have HbA1c $\geq$ 9% receive an endocrine consult prior to discharge. The EDOU, a short-stay unit attached to the ED, allows for the monitoring and management of patients who were treated in the ED but do not meet criteria for hospital admission [15]. This DM screening approach, initially instituted as a quality improvement project requiring collaboration between the Emergency Department and Division of Endocrinology, allows glucose management problems, including outpatient clinical inertia, to be identified and addressed in the acute care setting. This action leads to timely interventions and high patient satisfaction. Patients who had an endocrine consult in our EDOU also generally reported greater usage of their DM medications after 1 month compared to their usage before the consult [15]. Patients with severe hyperglycemia in the ED may be selected by the ED team to have a DM workup, a subsequent endocrine consult, and DM education in the EDOU [16]. Other institutions are implementing screening protocols to better identify undiagnosed diabetes in patients coming through the ED, such as one group utilizing EMR technology to flag patients at high risk [17].

In order to determine if severe hyperglycemia was being overlooked in the ED, we looked to see if the endocrinology service was being consulted for these cases, if initiations of, or modifications to a DM regimen were performed upon discharge, and if DM education was properly addressed in the ED note or discharge note. The fact that so few patients in the severe hyperglycemia group had an endocrine consult can be explained by our ED providers being more likely to admit patients to the EDOU for over 24 h of observation if they deem an endocrine consult to be necessary. This may also explain why almost all patients in our study had a history of DM and few had a new diagnosis, as new-onset DM is more likely to be sent to and evaluated in our EDOU.

While we did not find a significant association between the degree of BG control and hospital revisits, we still found that patients with DM having either a history of ASCVD or any ED visit in the prior year had a statistically significant increase in risk for hospital revisits within 30 days and 90 days. This finding presents an opportunity for prospective research to confirm this association. Meanwhile, this finding can be beneficial to ED providers so that patients who have these risk factors can be prioritized, and interventions can be made to reduce their risk of hospital revisits. Implementing a transition of care workflow for these higher risk patients could be extremely beneficial. For example, an interdisciplinary team can be utilized that includes a pharmacist and/or a certified DM educator to assist with follow-up phone calls, DM education, ensuring medications are picked up, and ensuring follow-up appointments are made in a timely manner. Pharmacists can play a key role in helping ED providers identify these high-risk patients, recommending appropriate therapies and dose adjustments for chronic medications, and providing DM education for their patients. Having transitions of care pharmacists call discharged patients for follow-up to ensure that discharge appointments were made and medications were picked up could be a beneficial area for further study [18]. Another interesting finding was that 70% of patients in the severe hyperglycemia group had a reason for the ED visit not related to their hyperglycemia, meaning that the BG level $\geq$ 300 mg/dL (16.7 mmol/L) was an incidental finding. This discovery also likely means that patients who presented to the ED due to hyperglycemia were sent to the EDOU and therefore were not included in this study [4,14]. Only 22.2% of patients in the severe hyperglycemia group had their DM addressed in the ED note or provider note. Additionally, any education notes were overall very general and not specific (e.g., "check your sugars", "avoid foods high in sugar", "seek immediate medical care for any new/worsening signs or symptoms", etc.). It is important for discharge instructions in these cases to be very clear and include the information that patients' BG levels are not well controlled with the emphasis that patients should follow-up with their primary care physician or endocrinologist to address this issue. What may be even more impactful would be to set up an appointment prior to discharge and to provide a phone number to call if patients' BG levels are consistently above a predefined threshold.

Limitations

Our study does have some noted limitations. It is a single center, relatively low-powered, retrospective chart review. The retrospective nature of this research is a limitation in regard to the interpretation of the data and conclusions. The fact that revisits were restricted to those within the health system is a limitation, though we did include 19 hospitals ranging over 100 miles and across five counties in New York. We did not look at data regarding revisits at other local hospitals, and, therefore, the revisits found through this study may have underestimated the true number of hospital revisits. Due to feasibility reasons, our study only looked at index visits that occurred within a 3-month period, January to March, and seasonal differences may have been in place. Additionally, our sample size may not have been sufficiently powered to detect statistically significant differences. While a multivariable model was used to adjust for some confounding factors, it is still possible that there is some unmeasured confounding. Future studies should involve a larger sample size, look at index visits occurring within at least a 1-year span and include revisits to nearby hospitals to mitigate these concerns.

It is worth noting that one patient was classified as having severe hyperglycemia when they should have been in the moderate hyperglycemia cohort. However, this single misclassification is not thought to meaningfully alter the conclusions.

Another limitation has to do with the lack of available HbA1c results, which limits the definition of DM control to one ED visit and even to one or two fingersticks. There can be inciting events causing the hyperglycemia seen during the ED visit such as infection, and the authors did not collect data on medications or fluids given during the initial ED visit. Although this is reflective of what information is typically available in an ED setting, and a prospective case series by Silverman et al. found a correlation between the BG level in ED

patients and HbA1c (r = 0.60, $p < 0.001$) [3], it still is not a completely accurate portrayal of a patient's true DM control. In this study, HbA1c data were only collected during the patient's index visit; if patients' repeat visits had an HbA1c result, it was not recorded. Also, the potential abridged (or lack of) documentation that is inherent and unavoidable in the ED is a limitation to this study.

Lastly, while random elevated BG values in the ED correlate with elevated HbA1c, the average HbA1c values reported in this paper are based on only small numbers of patients. This is because the HbA1c was not measured in most ED patients included in this analysis, which may contribute some selection bias. The authors acknowledge that 219 patients with diabetes were transferred to the EDOU during the study time period (where HbA1c is typically drawn) and not included in this study. This workflow of selecting for more at-risk patients may not be available at outside hospitals, which can limit the generalizability of the results.

5. Conclusions

The all-cause hospital revisit rate was not significantly different between cohorts with severe hyperglycemia, moderate hyperglycemia, and normal BG in our study. However, an increased risk of 30-day and 90-day revisits was found as part of an exploratory analysis in patients with DM having a history of ASCVD or any ED visit in the prior year, and further research is warranted to support these findings. Opportunities for improvement exist in addressing uncontrolled DM in patients being discharged from the ED. Our institution's DM screening protocol utilizing the EDOU, as described above, seems to be successful in capturing some of the ED patients identified as higher risk due to hyperglycemia. Another area of possible future study is the prescribing of GLP-1 agonists or SGLT2 inhibitors to patients with DM and ASCVD getting discharged from our emergency departments.

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References

1. Centers for Disease Control and Prevention. National Diabetes Statistics Report. 2017. Available online: https://www.cdc.gov/diabetes/php/data-research/index.html (accessed on 17 September 2019).
2. Rouse, M.D.; Shoukry, C.L. Elevated blood glucose levels in the emergency department: Missed opportunities. *J. Emerg. Nurs.* **2014**, *40*, 311–316. [CrossRef]
3. Silverman, R.A.; Pahk, R.; Carbone, M.; Wells, E.; Mitzner, R.; Burris, K.; Kelson, J.R.; Grella, R.; Katzeff, H. The relationship of plasma glucose and HbA1c levels among emergency department patients with no prior history of diabetes mellitus. *Acad. Emerg. Med.* **2006**, *13*, 722–726. [PubMed]
4. Crilly, C.J.; Allen, A.J.; Amato, T.M.; Tiberio, A.; Schulman, R.C.; Silverman, R.A. Evaluating the emergency department observation unit for the management of hyperglycemia in adults. *Am. J. Emerg. Med.* **2018**, *36*, 1975–1979. [CrossRef] [PubMed]
5. Driver, B.E.; Olives, T.D.; Bischof, J.E.; Salmen, M.R.; Miner, J.R. Discharge glucose is not associated with short-term adverse outcomes in emergency department patients with moderate to severe hyperglycemia. *Ann. Emerg. Med.* **2016**, *68*, 697–705.e3. [CrossRef] [PubMed]
6. Driver, B.E.; Klein, L.R.; Cole, J.B.; Prekker, M.E.; Fagerstrom, E.T.; Miner, J.R. Comparison of two glycemic discharge goals in ED patients with hyperglycemia, a randomized trial. *Am. J. Emerg. Med.* **2019**, *37*, 1295–1300. [CrossRef] [PubMed]

7. Günsoy, E.; Selman, F.; Duyan, M.; Ünal, A.Y. Determinant of the frequency of short-term undesirable events in diabetes discharged from the emergency department. *SN Compr. Clin. Med.* **2023**, *5*, 89. [CrossRef]
8. Diabetes.co.uk. Blood Sugar Converter. Available online: https://www.diabetes.co.uk/blood-sugar-converter.html (accessed on 10 September 2019).
9. Yan, J.W.; Gushulak, K.M.; Columbus, M.P.; van Aarsen, K.; Hamelin, A.L.; Wells, G.A.; Stiell, I.G. Risk factors for recurrent emergency department visits for hyperglycemia in patients with diabetes mellitus. *Int. J. Emerg. Med.* **2017**, *10*, 23. [CrossRef] [PubMed]
10. We are Northwell Health. January 2018. Available online: https://www.northwell.edu/sites/northwell.edu/files/d7/Fact-Sheet-January-2018.pdf (accessed on 4 November 2024).
11. Long Island Jewish Medical Center Northwell Health. Emergency Department. Available online: https://lij.northwell.edu/emergency-department (accessed on 11 March 2024).
12. American Diabetes Association Professional Practice Committee; ElSayed, N.A.; Aleppo, G.; Bannuru, R.R.; Bruemmer, D.; Collins, B.S.; Ekhlaspour, L.; Gaglia, J.L.; Hilliard, M.E.; Johnson, E.L.; et al. 9. Pharmacologic approaches to glycemic treatment: Standards of care in diabetes—2024. *Diabetes Care* **2024**, *47* (Suppl. S1), S158–S178.
13. Hicks, K.A.; Mahaffey, K.W.; Mehran, R.; Nissen, S.E.; Wiviott, S.D.; Dunn, B.; Solomon, S.D.; Marler, J.R.; Teerlink, J.R.; Farb, A.; et al. 2017 cardiovascular and stroke endpoint definitions for clinical trials. *Circulation* **2018**, *137*, 961–972. [PubMed]
14. Silverman, R.A.; Schleicher, M.G.; Valente, C.J.; Kim, M.; Romanenko, Y.; Schulman, R.C.; Tiberio, A.; Greenblatt, B.; Rentala, M.; Salvador-Kelly, A.V.; et al. Prevalence of undiagnosed dysglycemia in an emergency department observation unit. *Diabetes Metab. Res. Rev.* **2016**, *32*, 82–86. [CrossRef] [PubMed]
15. Schulman-Rosenbaum, R.C.; Hadzibabic, N.; Cuan, K.; Jornsay, D.; Wolff, E.; Tiberio, A.; Gottlieb, D.; Davis, F.; Silverman, R.A. Use of endocrine consultation for hemoglobin A1c $\geq$ 9.0% as a standardized practice in an emergency department observation unit. *Endocr. Pr.* **2021**, *27*, 1133–1138. [CrossRef] [PubMed]
16. Gottlieb, D.; Silverman, R.; Schulman-Rosenbaum, R.C. Diabetes Management in the Emergency Department. In *Diabetes Management in Hospitalized Patients*; Schulman-Rosenbaum, R.C., Ed.; Springer: Cham, Switzerland, 2024; pp. 149–163.
17. Danielson, K.K.; Rydzon, B.; Nicosia, M.; Maheswaren, A.; Eisenberg, Y.; Lin, J.; Layden, B.T. Prevalence of undiagnosed diabetes identified by a novel electronic medical record diabetes screening program in an urban emergency department in the US. *JAMA Netw Open* **2023**, *6*, e2253275. [CrossRef]
18. Bethishou, L.; Herzik, K.; Fang, N.; Abdo, C.; Tomaszewski, D.M. The impact of the pharmacist on continuity of care during transitions of care: A systematic review. *J. Am. Pharm. Assoc.* **2020**, *60*, 163–177. [CrossRef] [PubMed]

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