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RESEARCH

Continuous glucose monitoring to characterize hyperglycemia during chemotherapy for early stage breast cancer

Sophie R. Ulene[1] · Shikun Wang[2] · Joshua R. Cook[3] · Fiona McAuley[1] · Margaux E. Wooster[2] · Khadija F. Faheem[2] · Andrew Varoli[2] · Julia E. McGuinness[2] · Neil Vasan[2] · Meghna S. Trivedi[2] · Katherine D. Crew[2] · Erik Harden[2] · Cynthia Law[2] · Dawn L. Hershman[2] · Melissa K. Accordino[2]

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Abstract

Purpose Diabetes (DM) and hyperglycemia during chemotherapy increase the risk of toxicity, yet the prevalence and patterns of hyperglycemia in early-stage breast cancer (ESBC) patients undergoing chemotherapy with concurrent dexamethasone remain poorly understood.

Methods We conducted a prospective single-arm study using FreeStyle Libre Pro continuous glucose monitoring in patients with ESBC receiving chemotherapy from 12/2020–2/2022. Sensors measured interstitial glucose every 15 min and were reapplied every 2–3 weeks. Primary endpoints were (1) prevalence of hyperglycemia (≥ 1 reading ≥ 140 mg/dL), and (2) for those with hyperglycemia, the proportion of time spent hyperglycemic. Secondary endpoints included baseline glucose tolerance by A1c, changes in glucose-related biomarkers, and changes in patient-reported neuropathy, quality of life, and fatigue. Analysis was stratified by baseline A1c (euglycemic < 5.7%, prediabetes [pre-DM] 5.7–6.4%, diabetes [DM] ≥ 6.5%).

Results Among 20 evaluable patients (median age: 60, BMI: 29.5 kg/m^2), common chemotherapy regimens included docetaxel/cyclophosphamide (25%), paclitaxel/trastuzumab (20%), paclitaxel then doxorubicin/cyclophosphamide (15%), docetaxel/carboplatin/trastuzumab/pertuzumab (15%), and cyclophosphamide/methotrexate/fluorouracil (15%). All patients received Dexamethasone. At baseline, 10 patients were euglycemic, 7 had pre-DM, and 3 had DM. All experienced hyperglycemia. Of 124,165 total glucose readings, 17% were ≥ 140 mg/dL. By cohort, the proportion of time spent hyperglycemic was 3.9% (euglycemic), 10% (pre-DM), and 73.3% (DM) ($p < .0001$). Mean glucose values were 95.5 mg/dL (euglycemic), 104.5 mg/dL (pre-DM), and 183.0 mg/dL (DM) ($p < .0001$).

Conclusion All patients receiving chemotherapy for ESBC experienced hyperglycemia, with time spent hyperglycemic varying significantly by baseline A1c. Future research should explore approaches to and benefits of improving glycemic control during treatment in patients with baseline dysglycemia.

Trial registration: NCT04473378

Keywords Chemotherapy · Early-stage breast cancer · Continuous glucose monitoring · Hyperglycemia · Diabetes

Introduction

An estimated 310,000 people in the United States are diagnosed with invasive breast cancer each year, with up to half of them treated with intravenous chemotherapy. Most breast cancer treatment regimens require the concurrent use of corticosteroids for prevention and management of nausea and vomiting and mitigation of hypersensitivity reactions [1]. However, these steroids are also associated with metabolic side effects, including the development of steroid-induced hyperglycemia (SIHG). While chemotherapy-related SIHG has been recognized as a concern, the prevalence, patterns,

✉ Sophie R. Ulene
su2232@cumc.columbia.edu

[1] Vagelos College of Physicians and Surgeons, Columbia University Medical Center, New York, NY, USA

[2] Herbert Irving Comprehensive Cancer Center, Columbia University Medical Center, New York, NY, USA

[3] Division of Endocrinology, Diabetes, and Metabolism, Columbia University Medical Center, New York, NY, USA

and clinical implications of hyperglycemia in early-stage breast cancer (ESBC) patients undergoing treatment are not well characterized [2].

Hyperglycemia during chemotherapy is associated with worse treatment outcomes, including increased toxicity and adverse events [3–6]. One retrospective analysis of 243 non-metastatic breast cancer patients found that those who developed hyperglycemia during treatment had more frequent healthcare utilization, adverse events, and treatment modifications compared to their euglycemic counterparts, independent of baseline diabetes status [4]. Similarly, patients with diabetes mellitus (DM) are at increased risk of chemotherapy-related adverse events and early treatment termination if they have worse baseline glycemic control (defined by baseline HbA1c levels) [7]. In a large cohort of over 1,400 breast cancer patients enrolled in SWOG Cancer Research Network clinical trials, patients with preexisting DM had a 1.7-fold increased risk of developing chemotherapy-induced peripheral neuropathy (CIPN) compared to those without DM [8].

Efforts to address chemotherapy-related hyperglycemia are emerging but remain limited. A recent narrative review highlighted the complexity of managing SIHG in cancer patients in the outpatient setting, identifying few prospective studies and emphasizing the need for standardized screening and evaluations of clinical outcomes and patient experiences [9]. The ONCODIAB study demonstrated the feasibility of continuous glucose monitoring (CGM)-guided interventions in patients with diabetes undergoing chemotherapy, resulting in fewer hypoglycemic episodes when comparing pre- and post-intervention CGM data [10]. Despite these advances, the prevalence, time-course, and clinical impact of hyperglycemia in ESBC patients undergoing chemotherapy remain poorly understood. To address this gap, we utilized CGM to investigate glucose trends in this population. By assessing the patterns of hyperglycemia during chemotherapy, our study aims to inform future interventions to optimize glycemic control and improve patient outcomes.

Methods

We performed a prospective, observational, single-arm cohort study to characterize patterns of hyperglycemia during chemotherapy among patients with breast cancer. Participants were recruited from the Breast Oncology clinic at the Herbert Irving Comprehensive Cancer Center and were receiving either neoadjuvant or adjuvant chemotherapy between 12/2020 and 2/2022. The primary objectives of this study were to determine the prevalence of hyperglycemia in this population and, among those who developed hyperglycemia, to quantify the proportion of time spent hyperglycemic. Secondary objectives included assessing baseline glucose tolerance, as measured by hemoglobin A1c, and evaluating changes over time in both glucose-related biomarkers and patient-reported outcomes, including neuropathy, quality of life, and fatigue.

Participants

Patients were eligible to participate if they were ≥ 18 years old, had a diagnosis of stage I-III breast cancer, were scheduled to receive adjuvant or neoadjuvant chemotherapy with concurrent corticosteroids, and were not being treated with insulin or systemic steroids at baseline. Oral hypoglycemic medications (e.g. metformin) were allowed. Written informed consent was obtained from all individual participants included in the study.

Measurements

Within 7 days of chemotherapy initiation, the Freestyle Libre Pro (Abbott Diabetes Care) continuous glucose monitoring system was applied to the posterior arm of each participant by a member of the study team [11]. The Freestyle Libre Pro measured interstitial glucose every 15 min for 14 consecutive days, or until the sensor fell off, via subcutaneous filaments. Patches were reapplied every 2 weeks for patients undergoing weekly chemotherapy and every 3 weeks for patients undergoing triweekly chemotherapy and worn continuously until regimen completion. At the time of sensor changes, patches were scanned to download results, and upon receipt of sensor data, the study PI or another physician on the team reviewed the reports generated by LibreView for potential patient safety concerns. Patients remained blinded to their glucose trends and reports were not regularly reviewed by their treating physicians. Treatment regimens, duration, and modifications to chemotherapy were at the discretion of the patient's treating physician. Patients were followed for 24 weeks regardless of the duration of chemotherapy regimen.

Biomarkers

Laboratory biomarkers assessed using standard clinical laboratory protocols included: hemoglobin A1c and insulin at baseline, week 12, and week 24, and fructosamine, serum glucose, and serum creatinine at baseline and every 3 weeks thereafter (weeks 15, 18, and 21 were optional if participants had completed chemotherapy) [12]. These biomarkers were chosen to provide both short- and long-term assessments of glycemic control and insulin response during chemotherapy. Hemoglobin A1c reflects average blood glucose over the past 2 to 3 months, while fructosamine measures average blood glucose levels over the previous 2 to 4 weeks, and can be used as a more immediate indicator of changes in glycemic control compared to HbA1c [13, 14]. Serum creatinine

was included to monitor renal function, which may affect insulin clearance and blood glucose levels.

Physical exam

At baseline, week 12, and week 24, participants underwent assessment of BMI and waist circumference.

Patient reported outcomes

Participants completed patient reported outcome assessments at baseline, week 12, and week 24. All questionnaires were available in English and Spanish and took approximately 15 min to complete. They were administered in clinic at each time-point with assistance from a member of the research team. CIPN was assessed using the EORTC-CIPN 20, a 20-item questionnaire that evaluates neuropathy using 3 subscales: sensory, motor, and autonomic, and that has been previously validated in patients with cancer [15]. Quality of life was assessed using PROMIS-29 v2.1, which evaluates seven domains (physical function, anxiety, depression, fatigue, sleep disturbance, social functioning, and pain interference) using a 5-point Likert scale [16]. Fatigue was assessed using the Brief Fatigue Index (BFI), a 9-item questionnaire that has also been validated for the assessment of fatigue in patients with cancer [17, 18]. BFI scores are categorized as mild (score 1–3), moderate (4–6), and severe (7–10).

Endpoints

Our primary objective was to determine the prevalence of hyperglycemia, defined as the number of participants with at least 1 glucose reading ≥ 140 mg/dL. The value of 140 mg/dL is considered clinically significant and has been used as a definition for hyperglycemia among patients without diabetes in previous studies [19–21]. Specifically, we sought to determine, among participants who developed hyperglycemia, the proportion of time they spent hyperglycemic, defined as number of readings ≥ 140 mg/dL divided by total number of readings.

Our secondary objectives included: prevalence of prediabetes (pre-DM, A1c 5.7%−6.4%) and diabetes (DM, A1c ≥ 6.5% and/or clinical diagnosis prior to study enrollment) at baseline and changes in biomarkers, BMI, waist circumference, and patient reported outcomes from baseline at weeks 12 and 24 [22].

Statistical analysis

The analysis was stratified by baseline A1c as a proxy for baseline glucose tolerance levels. Participants were considered to have euglycemia if their baseline A1c was < 5.7% (euglycemia group), prediabetes if their baseline A1c was 5.7–6.4% (pre-DM group), or diabetes if their baseline A1c was ≥ 6.5% and/or they had a clinical diagnosis of diabetes mellitus prior to study enrollment (DM group) [22]. We stratified the groups by baseline A1c to assess the differential impact of prediabetes and diabetes on glucose control during chemotherapy, as these conditions have distinct pathophysiologic profiles and responded differently to steroids in prior studies of SIHG [23, 24]. Prevalence of hyperglycemia was defined as the number of participants with at least one glucose value of ≥ 140 mg/dL at any point during chemotherapy. The proportion of time patients had hyperglycemia was calculated by dividing the number of hyperglycemic values by all recorded glucose values for an individual. Paired t-tests were used to calculate changes in body mass index (BMI), waist circumference, and glucose biomarkers (fructosamine, serum glucose, serum creatinine, hemoglobin a1c, insulin) at 12 weeks and at 24 weeks compared to baseline. Chi-Squared/Fisher's exact tests and paired t-tests were used to evaluate changes in the EORTC-CIPN-20, PROMIS-29, and BFI. Groups were compared using one-way ANOVA with pairwise comparisons and considered significantly different if P-values were < 0.05.

Results

Patient characteristics

Of the 24 patients who signed informed consent, 1 was deemed ineligible and 3 withdrew consent prior to completion. Among the 20 evaluable participants, the median age at baseline was 60 (range 34–78) and the median body mass index (BMI) was 29.5 kg/m2 (range 19.5–41.6), which falls into the overweight category. The most common chemotherapy regimens included docetaxel and cyclophosphamide (25%), weekly paclitaxel and trastuzumab (20%), paclitaxel followed by doxorubicin and cyclophosphamide (15%), docetaxel, carboplatin, trastuzumab, and pertuzumab (15%), and cyclophosphamide, methotrexate, and fluorouracil (15%) (Table 1). Eight patients received chemotherapy for ≤ 12 weeks, while 12 patients received chemotherapy for > 12 weeks. At baseline, all 3 patients in the DM group were taking oral hypoglycemic medications (regimens were: metformin; metformin/canagliflozin; metformin/sitagliptin/dapagliflozin), while no patients in the pre-DM or euglycemic groups were taking oral hypoglycemic medications. All enrolled patients received oral and/or IV dexamethasone in conjunction with their treatment sessions. Doses were at the discretion of the treating provider.

Table 1 Patient Characteristics[a]

Baseline Demographics	(n = 20)
Age at Consent	
≤ 39	4 (20.0%)
40–49	2 (10.0%)
50–59	4 (20.0%)
60–69	4 (20.0%)
≥ 70	6 (30.0%)
Median age (range)	60 (34–78)
Race	
White	11 (55.0%)
Black or African American	4 (20.0%)
Asian	3 (15.0%)
Other	2 (10.0%)
Ethnicity	
Hispanic or Latino	6 (30.0%)
Not Hispanic or Latino	13 (65.0%)
Unknown	1 (5.0%)
BMI	
BMI 18.5–24.9 kg/m^2	6 (30.0%)
BMI 25–29.9 kg/m^2	4 (20.0%)
BMI > 30 kg/m^2	10 (50.0%)
Education Level	
Did not finish high school	3 (15.0%)
High school or equivalent	2 (10.0%)
Some college	3 (15.0%)
College	4 (20.0%)
Graduate school	8 (40.0%)
Diabetes Status	
DM (Diagnosis at baseline)	3 (15.0%)
Non-DM (No diagnosis at baseline)	17 (85.0%)
Chemotherapy Regimens	
≤ 12 weeks duration	
TC × 4	3 (15.0%)
TH × 12	4 (20.0%)
Taxol/Carbo/Pembro(q3) × 12	1 (5.0%)
> 12 weeks duration	
TC × 6	2 (10.0%)
TCHP × 6	3 (15.0%)
P × 12 → AC × 4	3 (15.0%)
CMF × 8	3 (15.0%)
THP × 4 → AC	1 (5.0%)

[a]Chemotherapy abbreviations: TC = docetaxel + cyclophosphamide; P× 12—> AC × 4 = paclitaxel → adriamycin + cyclophosphamide; TCHP = docetaxel + carboplatin + trastuzumab + pertuzumab; CMF = cyclophosphamide + methotrexate + fluorouracil; TH = paclitaxel + trastuzumab; THP = docetaxel + trastuzumab + pertuzumab; HP = trastuzumab + pertuzumab

Glucose trends

The number of blood glucose measurements and days recorded did not differ significantly across sub-groups. All 20 patients had at least one episode of hyperglycemia. Of 124,165 total readings across all groups, 17% were ≥ 140 mg/dL (Clopper–Pearson 95% CI 0.170, 0.174), and the mean glucose measurement was 112.7 mg/dL. At baseline, n = 10 subjects were considered euglycemic, n = 7 had pre-DM, and n = 3 had DM. Both the proportion of time spent hyperglycemic and the overall mean glucose values differed significantly by baseline glucose tolerance. The euglycemia group spent 3.9% of the time hyperglycemic, the pre-DM group 10%, and the DM group 73.3% ($p < 0.0001$) (Fig. 1). The euglycemia group had an overall mean glucose value of 95.5 mg/dL, the pre-DM group 104.5 mg/dL, and the DM group 183.0 mg/dL ($p < 0.0001$).

The mean time from corticosteroid administration to first hyperglycemic episode was 0.6 h in the DM group, 5.4 h in the pre-DM group, and 93.3 h in the euglycemia group (log-rank p-value < 0.001). Participants' mean hourly glucose trends after their first administration of dexamethasone can be seen in Fig. 2. The DM and pre-DM groups both reached their maximum mean glucose levels within the first 12 h after steroid administration, and all groups reached their maximum within 24 h. (Figs. 2, 3).

Biomarkers

At baseline, mean group hemoglobin A1c levels were: 7.2% in the DM group, 5.8% in the pre-DM group, and 5.1% in the euglycemia group. At week 12, mean A1c levels increased in all 3 groups: the pre-DM group increased the most (+ 0.3 to 6.1%), followed by the DM group (+ 0.13%) and finally the euglycemia group (+ 0.03%) ($p < 0.0001$). By week 24, while the changes in A1c still differed significantly across groups, only the DM group had a net increase in A1c (+ 0.1% from 7.2 to 7.3%).

Change in fructosamine from baseline differed significantly across groups at week 12 ($p = 0.0005$) and week 24 ($p < 0.05$). At week 12, only the DM group had experienced a net increase in fructosamine, while by week 24, only the pre-DM group had experienced a net increase. Serum creatinine and serum insulin did not differ significantly across groups at any time point (Table 2).

Patient reported outcomes

Peripheral neuropathy In the DM group (n = 3), one patient reported decreased sensation at week 12, which increased to two patients at week 24, per the sensory subscale of the CIPN questionnaire. In the pre-DM group (n = 7), six patients reported decreased sensation at week 12,

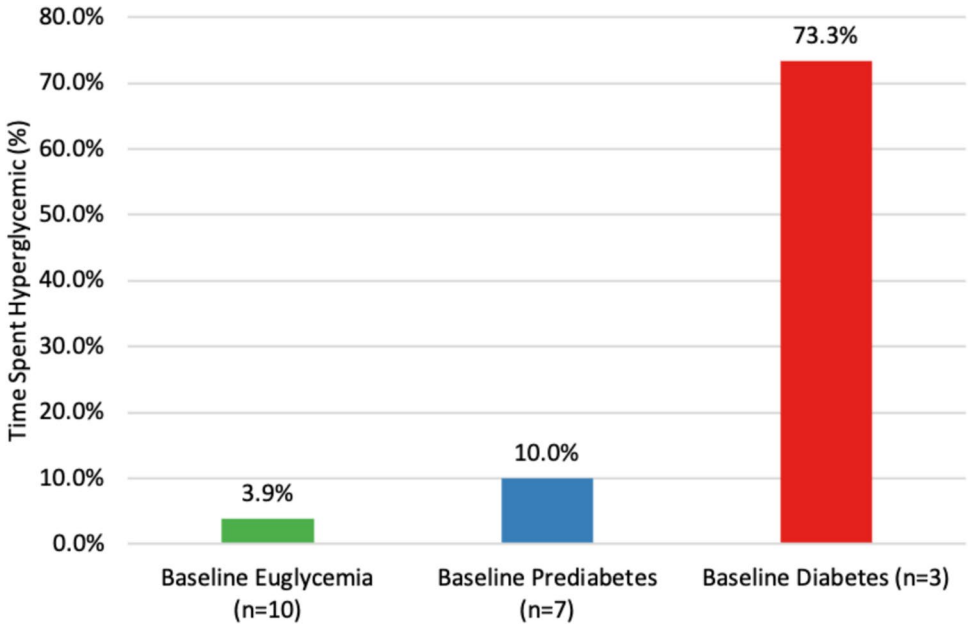

Fig. 1 Percent of time spent hyperglycemic (≥ 140 mg/dL) by cohort

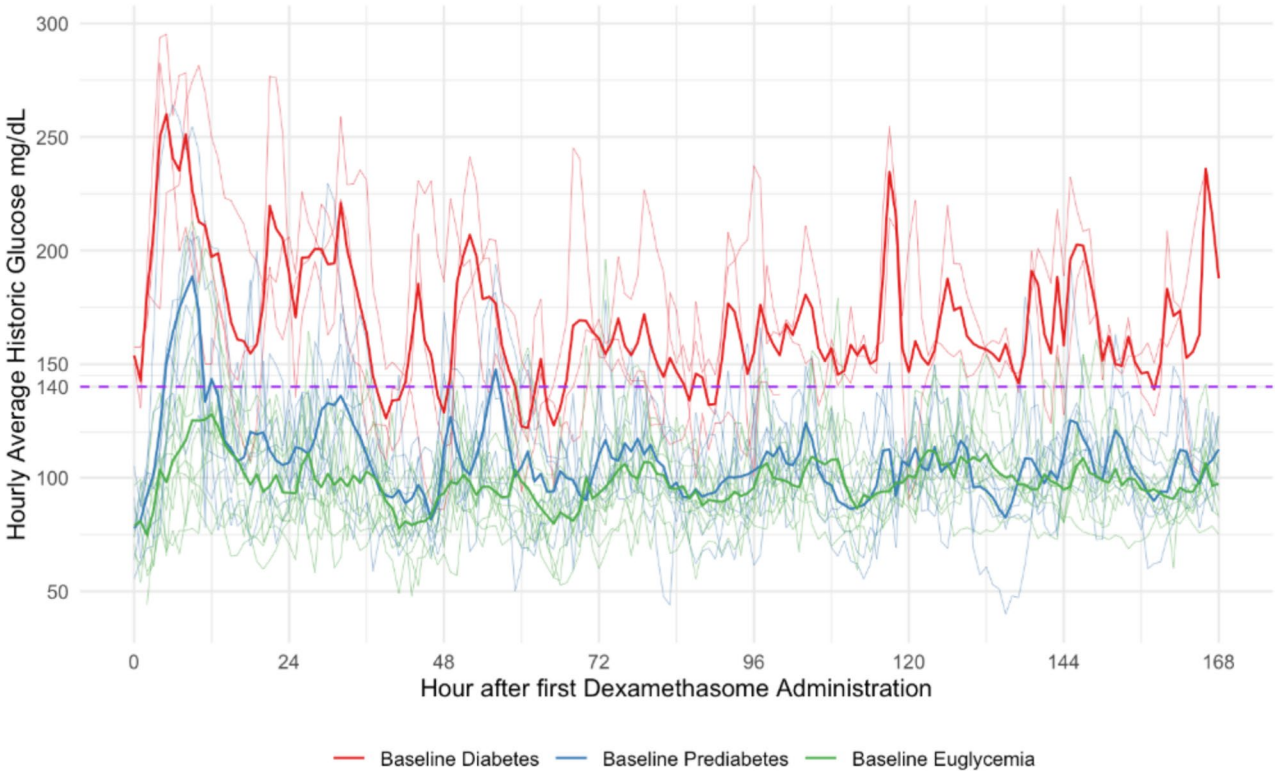

Fig. 2 Rolling hourly mean glucose days 0–7 after first Dexamethasone administration by group

decreasing to five patients at week 24. In the euglycemic group (n = 10), three patients reported decreased sensation at week 12, decreasing to one patient at week 24. (Supplemental Table 1).

Quality of life At weeks 12 and 24, participants' ability to engage in social roles and activities decreased from baseline across all cohorts, with the largest decline in the DM group and the smallest in the euglycemic group (maximum scaled

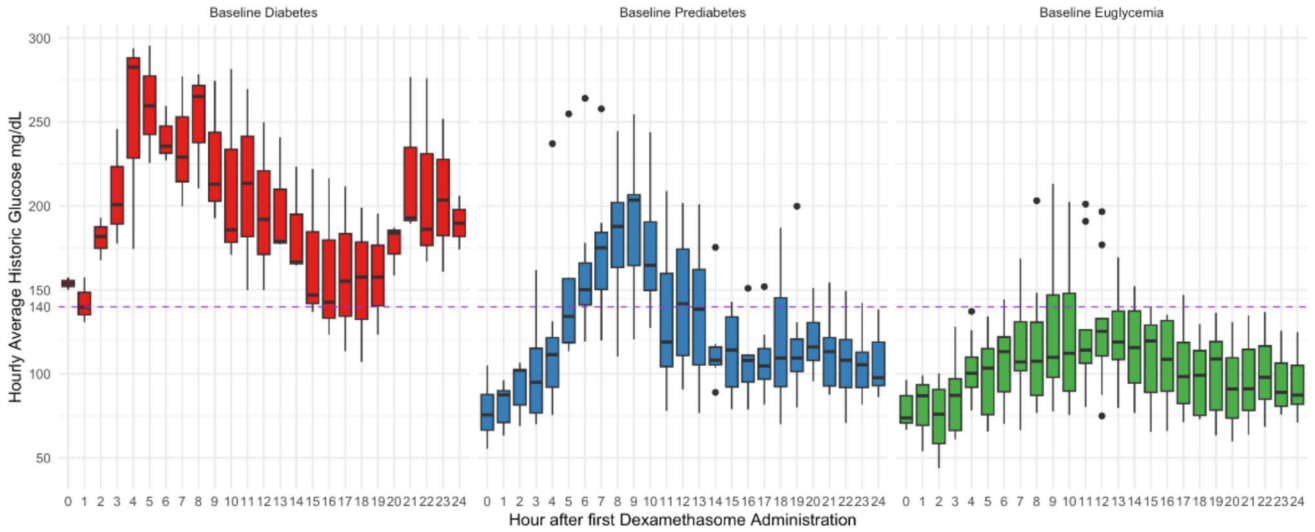

Fig. 3 Hourly glucose levels 24 h post-Dexamethasone administration by group

Table 2 Biomarkers over time stratified by group

	All Patients (n = 20)	Baseline Diabetes (n = 3)	Baseline Prediabetes (n = 7)	Baseline Euglycemia (n = 10)	P-value
Fructosamine					
Fructosamine Baseline	**257.5 [242.7, 272.2]**	**307 [185.8, 428.2]**	**247 [231.3, 262.7]**	**249.9 [235.6, 264.2]**	**0.005**
Fructosamine Week 12	**245.6 [229.3, 261.9]**	**307.7 [207.2, 408.2]**	**236.1 [215.7, 256.6]**	**233.6 [220.3, 246.9]**	**5.00E-04**
Fructosamine Week 24	**260.8 [244.5, 277.2]**	**301 [174.7, 427.4]**	**262.3 [241.5, 283.2]**	**247.9 [227.97, 267.83]**	**0.05**
Creatinine					
Creatinine Baseline	0.9 [0.4, 1.1]	0.8 [0.3, 1.2]	1.2 [0.7, 1.6]	0.8 [0.6, 1.0]	0.1
Creatinine Week 12	0.9 [0.7, 1.1]	0.7 [0.1, 1.3]	1.2 [0.6, 1.8]	0.8 [0.6, 1.0]	0.09
Creatinine Week 24	0.9 [0.7, 1.1]	0.7 [0.1, 1.4]	1.19 [0.5, 1.9]	0.8 [0.6, 1.0]	0.2
A1C					
A1C Baseline	**5.7 [5.3, 6.1]**	**7.23 [5.6, 8.8]**	**5.8 [5.7, 5.9]**	**5.1 [4.9, 5.3]**	**< 0.0001**
A1C Week 12	**5.8 [5.3, 6.3]**	**7.4 [3.6, 11.1]**	**6.1 [5.8, 6.4]**	**5.12 [4.9, 5.3]**	**< 0.0001**
A1C Week 24	**5.6 [5.1, 6.2]**	**7.3 [1.9, 12.8]**	**5.8 [5.3, 6.2]**	**5.1 [4.8, 5.3]**	**0.003**
Insulin					
Insulin Baseline	24.8 [10.8, 38.9]	12 [7.7, 16.3]	24.3 [−1.1, 49.6]	29.6 [2.2, 56.9]	0.7
Insulin Week 12	29.7 [14.4, 45.1]	10.3 [−2.4, 23.1]	40.2 [9.9, 70.4]	29.3 [2.9, 55.7]	0.4
Insulin Week 24	21.5 [9.5, 33.5]	18 [−10.7, 46.7]	39.2 [−0.5, 78.9]	11.9 [4.5, 19.3]	0.1

score 64.2; change at week 12: − 11.8 DM, − 5.8 pre-DM, − 0.4 euglycemic; change at week 24: − 2.8 DM, − 1.7 pre-DM, − 0.1 euglycemic). At weeks 12 and 24, the DM group reported an increase in pain intensity from baseline while the other 2 groups had no change at week 12 and improved pain at week 24. (Supplemental Table 2).

Fatigue The overall fatigue index score average across all groups was 3.0 at baseline (mild), 4.6 at week 12 (moderate), and 3.4 at week 24 (mild). While overall fatigue scores and changes in scores from baseline did not differ significantly between groups, the DM group experienced the greatest increases in overall scores as well as the severity and interference subscales. At week 24, an increase in fatigue interference in daily life compared to baseline was reported by 100% in the DM group (n = 3), 60% in the pre-DM group (n = 3), and 28.6% in the euglycemic group (n = 2). (Supplementary Table 3).

Discussion

In this study of continuous glucose monitoring, we found that all patients with ESBC who received chemotherapy with dexamethasone premedication experienced at least one episode of hyperglycemia. Notably, both the proportion of time that patients spent hyperglycemic and the time from steroid administration to the onset of hyperglycemia differed significantly depending on baseline glucose tolerance. Participants with diabetes at baseline experienced the earliest onset and highest prevalence of hyperglycemia and the greatest increases in hemoglobin A1c, neuropathy, and fatigue, while those who were euglycemic at baseline had the latest onset and lowest prevalence of hyperglycemia and experienced the smallest increases in A1c, neuropathy, and fatigue.

Our findings are consistent with emerging literature on steroid-induced hyperglycemia across diverse patient populations, an issue that has gained attention since the COVID-19 pandemic led to the increased use of corticosteroids globally [25, 26]. Research suggests that the hyperglycemic effects of corticosteroids are dose- and duration-dependent and can occur within hours of administration [27–29]. However, efforts to mitigate these effects by reducing the dexamethasone dose on the first day of each chemotherapy cycle have been associated with increased nausea and vomiting, reinforcing the necessity of steroids in cancer treatment [30, 31]. Stratifying patients by baseline glucose tolerance, a recent prospective study using CGM in dermatology patients receiving high-dose corticosteroids found that the incidence of hyperglycemia doubled with each stepwise change in baseline glucose tolerance (euglycemic, prediabetes, diabetes) [24]. Similarly, in hospitalized patients with COVID-19 treated with dexamethasone, those with higher baseline A1c levels experienced more frequent hyperglycemia and required higher insulin doses [32]. This underscores the role of baseline glycemic status in predicting hyperglycemia during treatment with corticosteroids, as supported by our results. However, prior studies of SIHG have largely been conducted with acutely ill inpatients receiving prolonged courses of treatment-dose steroids and may not be generalizable to our patient population, *i.e.* people with cancer receiving short courses of corticosteroids for side effect prevention in the outpatient setting.

Patients receiving corticosteroids alongside chemotherapy face a different set of clinical challenges compared to non-cancer patients receiving treatment-dose steroids. Chemotherapy-induced peripheral neuropathy (CIPN) is one of the most common and debilitating toxicities associated with cancer treatment. A meta-analysis by Gu et al. identified diabetes as a significant risk factor for developing CIPN, with an odds ratio of 1.60 (CI = 1.38–1.85, $P < 0.001$) compared to patients without diabetes at baseline [33]. Our group's recent CIPN prevention study also found that patients who experienced neuropathy after chemotherapy had higher mean glucose values at all measured timepoints compared to those who did not, although preexisting diabetic neuropathy may have contributed to these results [34]. In the current study cohort, by week 24, approximately two-thirds of patients with diabetes or pre-diabetes reported decreased sensation from baseline, while only 10% of the euglycemic group reported similar effects. This highlights the heightened vulnerability of patients with impaired glucose metabolism to treatment-related toxicities such as CIPN. Given the limited options currently available for CIPN prevention and management, optimization of glucose control may be a promising strategy to mitigate the risk of this toxicity.

Hyperglycemia during chemotherapy may also affect cancer outcomes. Research suggests that hyperglycemia may lead to decreased treatment efficacy by contributing to chemotherapy resistance and promoting tumor proliferation across multiple cancer types [35–37]. In a retrospective study of 936 breast cancer patients without diabetes who underwent the same chemotherapy regimen, those who remained euglycemic throughout treatment had significantly higher 5-year relapse-free survival compared to those who developed hyperglycemia (92% and 82.3%, respectively) [3]. Similarly, poor glycemic control in patients with diabetes undergoing platinum-based chemotherapy for non-small cell lung cancer has been associated with significantly longer progression-free survival, and elevated fasting blood glucose has been identified as a negative prognostic predictor for patients with cervical cancer undergoing neoadjuvant chemotherapy [38, 39].

Our study contributes valuable insights to the growing body of research on blood glucose during chemotherapy, as it is among the first to capture CGM data throughout the treatment course. Because steroids primarily increase postprandial glucose levels, previous studies using daily or single time-point glucose measurements—often completed in clinic under fasting conditions—likely underreported hyperglycemia prevalence and incidence [40–42]. However, this study has several limitations. It was conducted at a single institution with a small sample size and was not adequately powered to find significant differences between cohorts based on baseline diabetes status. Within our sample, there was heterogeneity of chemotherapy regimens, dexamethasone dose exposure, comorbidities, and baseline glucose tolerance, as well as variation in the number of glucose levels recorded per participant. While we defined hyperglycemia as glucose levels above 140 mg/dL—consistent with glucose tolerance test criteria—levels may exceed this threshold following a carbohydrate-rich meal

in individuals with normal glucose tolerance, making it challenging to distinguish true hyperglycemia from a normal postprandial response in the absence of detailed meal timing data. Furthermore, observed symptoms were likely influenced by a combination of factors including hyperglycemia, chemotherapy toxicity, and underlying malignancy, and cannot be attributed to any one cause using observational data. Finally, the short 24-week study duration limited our ability to assess long-term health outcomes associated with chemotherapy-related hyperglycemia, and further research will be necessary to do so.

In summary, hyperglycemia is highly prevalent among patients receiving corticosteroids during chemotherapy, particularly during the first 24 h after steroid administration, and the time to onset of hyperglycemia and proportion of time spent hyperglycemic differ significantly by baseline glycemic control. Patients with pre-diabetes and diabetes at baseline are at a higher risk for treatment-related toxicities, including CIPN, and further research to evaluate interventions aimed at optimizing glucose control during chemotherapy should target these populations.

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Author contributions Study conception and design were carried out by MA and DH. Financial support was provided in part by DH. Administrative support was provided by KF, EH, and CL. JM, MT, NV, KC, DH, and MA provided study materials and/or patients. Data collection and assembly was performed by SU, KF, EH, DH, and MA. All authors contributed to data analysis and interpretation, manuscript writing, and final approval of the manuscript. All authors are accountable for all aspects of the work.

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Data availability The datasets generated and analyzed during the current study can be provided by the corresponding author on reasonable request.

Declarations

Competing interests Author JM has received honoraria from OncLive and WebMD, and has served on advisory boards for Seagen, Gilead, and AstraZeneca. Author EH receives research funding from NCI grant UG1 CA189960 and has been employed by the Globally Healthy Living Foundation. Author MA has served in a consulting role for Disney. All other authors report no competing financial or non-financial interests relevant to the content of this manuscript.

References

1. Hesketh PJ et al (2020) Antiemetics: ASCO guideline update. J Clin Oncol 38(24):2782–2797
2. Hwangbo Y, Lee EK (2017) Acute hyperglycemia associated with anti-cancer medication. Endocrinol Metab (Seoul) 32(1):23–29
3. Ahn HR et al (2020) Hyperglycemia during adjuvant chemotherapy as a prognostic factor in breast cancer patients without diabetes. J Breast Cancer 23(4):398–409
4. Phillips AL, Reeves DJ, Storey S (2023) Impact of diabetes (type 2) and glycemic control on health-related outcomes of patients receiving chemotherapy for non-metastatic breast cancer: a retrospective analysis. Support Care Cancer 31(2):114
5. Brunello A, Kapoor R, Extermann M (2011) Hyperglycemia during chemotherapy for hematologic and solid tumors is correlated with increased toxicity. Am J Clin Oncol 34(3):292–296
6. Kristjanson M et al (2023) Steroid-induced hyperglycemia and Its effect on outcomes of R-CHOP chemotherapy for diffuse large B-Cell lymphoma. Curr Oncol 30(12):10142–10151
7. Hershey DS, Hession S (2017) Chemotherapy and glycemic control in patients with type 2 diabetes and cancer: a comparative case analysis. Asia Pac J Oncol Nurs 4(3):224–232
8. Hershman DL et al (2016) Comorbidities and risk of chemotherapy-induced peripheral neuropathy among participants 65 years or older in southwest oncology group clinical trials. J Clin Oncol 34(25):3014–3022
9. Kandil I, Keely E (2022) Glucocorticoid-induced hyperglycemia in oncologic outpatients: a narrative review using the quadruple aim framework. Can J Diabetes 46(7):730–739
10. Legris P et al (2023) Glycemic control in people with diabetes treated with cancer chemotherapy: contribution of continuous glucose monitoring. Acta Diabetol 60(4):545–552
11. FreeStyle Libre Pro Product. [cited 2024 November 1]; Available from: https://www.myfreestyle.com.
12. 6. Glycemic goals and hypoglycemia: standards of care in diabetes-2024. Diabetes Care, 2024. **47**(Suppl 1): p. S111-s125.
13 Shohat N et al (2019) 2019 John Insall Award: Fructosamine is a better glycaemic marker compared with glycated haemoglobin (HbA1C) in predicting adverse outcomes following total knee arthroplasty: a prospective multicentre study. Bone Joint J 101-b(7_Supple_C):3–9
14. Malmström H et al (2014) Fructosamine is a useful indicator of hyperglycaemia and glucose control in clinical and epidemiological studies–cross-sectional and longitudinal experience from the AMORIS cohort. PLoS ONE 9(10):e111463
15. Postma TJ et al (2005) The development of an EORTC quality of life questionnaire to assess chemotherapy-induced peripheral neuropathy: the QLQ-CIPN20. Eur J Cancer 41(8):1135–1139
16. PROMIS Scoring Guideline: Overview. [cited 2024 November 30]; Available from: https://www.assessmentcenter.net.
17. Mendoza TR et al (1999) The rapid assessment of fatigue severity in cancer patients: use of the brief fatigue inventory. Cancer 85(5):1186–1196
18. Minton O, Stone P (2009) A systematic review of the scales used for the measurement of cancer-related fatigue (CRF). Ann Oncol 20(1):17–25
19. Shah VN et al (2019) Continuous glucose monitoring profiles in healthy nondiabetic participants: a multicenter prospective study. J Clin Endocrinol Metab 104(10):4356–4364
20. Soysal DE et al (2012) Evaluation of transient hyperglycemia in non-diabetic patients with febrile neutropenia. Eur J Intern Med 23(4):342–346
21. Sonabend RY et al (2008) Hyperglycemia during induction therapy is associated with increased infectious complications in childhood acute lymphocytic leukemia. Pediatr Blood Cancer 51(3):387–392
22. 2. Diagnosis and classification of diabetes: standards of care in diabetes-2024. Diabetes Care, 2024. **47**(Suppl 1): p. S20-s42.
23. Yuen KC, McDaniel PA, Riddle MC (2012) Twenty-four-hour profiles of plasma glucose, insulin, C-peptide and free fatty acid in subjects with varying degrees of glucose tolerance following short-term, medium-dose prednisone (20 mg/day) treatment:

evidence for differing effects on insulin secretion and action. Clin Endocrinol (Oxf) 77(2):224–232
24. Kleinhans M et al (2024) Continuous glucose monitoring of steroid-induced hyperglycemia in patients with dermatologic diseases. J Diabetes Sci Technol 18(4):904–910
25. Horby P et al (2021) Dexamethasone in hospitalized patients with Covid-19. N Engl J Med 384(8):693–704
26. Brooks D et al (2022) Glucocorticoid-induced hyperglycemia including dexamethasone-associated hyperglycemia in COVID-19 infection: a systematic review. Endocr Pract 28(11):1166–1177
27. Cho JH, Suh S (2024) Glucocorticoid-induced hyperglycemia: a neglected problem. Endocrinol Metab (Seoul) 39(2):222–238
28. Liu XX et al (2014) Hyperglycemia induced by glucocorticoids in nondiabetic patients: a meta-analysis. Ann Nutr Metab 65(4):324–332
29. Healy SJ et al (2017) Prevalence, predictors, and outcomes of steroid-induced hyperglycemia in hospitalized patients with hematologic malignancies. Endocrine 56(1):90–97
30. Saito Y et al (2022) Influence of dose reduction of prophylactic dexamethasone on chemotherapy-induced nausea and anorexia in patients under 55 years old treated with anthracycline-containing regimens. Anticancer Res 42(7):3753–3758
31. Saito Y et al (2021) Impact of reducing day 1 dexamethasone dose in anthracycline-containing regimens on acute gastrointestinal symptoms associated with breast cancer treatment. Sci Rep 11(1):23298
32. Gordon C et al (2023) Dexamethasone use and insulin requirements in coronovirus-19 (COVID-19) infection stratified by Hemoglobin A1c. Diabet Epidemiol Manag 10:100123
33. Gu J et al (2021) Diabetes mellitus as a risk factor for chemotherapy-induced peripheral neuropathy: a meta-analysis. Support Care Cancer 29(12):7461–7469
34 Klahr MP et al (2024) Association between hyperglycemia and the development of chemotherapy-induced peripheral neuropathy among patients with breast cancer. J Clin Oncol 42(16_suppl):12125–12125
35. Qiu J, Zheng Q, Meng X (2021) Hyperglycemia and chemoresistance in breast cancer: from cellular mechanisms to treatment response. Front Oncol 11:628359
36. Gerards MC et al (2017) Impact of hyperglycemia on the efficacy of chemotherapy-A systematic review of preclinical studies. Crit Rev Oncol Hematol 113:235–241
37. Zhang Y et al (2021) Dexamethasone enhances the lung metastasis of breast cancer via a PI3K-SGK1-CTGF pathway. Oncogene 40(35):5367–5378
38. Zeng X et al (2020) Poor glycemic control might compromise the efficacy of chemotherapy in non-small cell lung cancer patients with diabetes mellitus. Cancer Med 9(3):902–911
39. Li J et al (2016) Impact of Hyperglycemia on outcomes among patients receiving neoadjuvant chemotherapy for bulky early stage cervical cancer. PLoS ONE 11(11):e0166612
40. Shah P et al (2022) Management of glucocorticoid-induced hyperglycemia. Diabetes Metab Syndr Obes 15:1577–1588
41. Lyall MJ et al (2018) Diurnal profile of interstitial glucose following dexamethasone prophylaxis for chemotherapy treatment of gynaecological cancer. Diabet Med 35(11):1508–1514
42. Cansu GB et al (2019) What is the optimal time for measuring glucose concentration to detect steroid-induced hyperglycemia in patients with rheumatic diseases? Clin Biochem 67:33–39

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