Contents available at ScienceDirect

Diabetes Research and Clinical Practice

journal homepage: www.elsevier.com/locate/diabres

International Diabetes Federation

Routine HbA1c among hematology and oncology inpatients: Diabetes-status and hospital-outcomes

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ARTICLE INFO

Article history:
Received 5 February 2019
Received in revised form
25 April 2019
Accepted 3 May 2019
Available online 10 May 2019

Keywords:
Routine HbA1c
Hematology inpatients
Oncology inpatients
Known diabetes
Unrecognized diabetes
Hospital outcomes

ABSTRACT

Aims: Using routine HbA1c measurement to determine the prevalence of diabetes mellitus (known and previously unrecognized) and their hospital outcomes among hematology and oncology inpatients.

Methods: This was a prospective, observational study. Routine automated HbA1c testing was performed in all hematology and oncology inpatients aged ≥54 years at a tertiary hospital, July 2013-January 2015. The outcome measures were: (i) prevalence of known and previously unrecognized diabetes, and (ii) hospital outcomes: length-of-stay (LOS), intensive-care-unit (ICU) admission, 30-day/18-month readmission, and 18-month mortality.

Results: Over the 18-month study period, 1076 inpatients aged ≥54 years were admitted to hematology (n = 298) and oncology (n = 778) units: 21% had known diabetes and 7% had previously unrecognized diabetes. Patients with known diabetes had a longer LOS (IRR: 1.18, 95%CI: 1.02–1.37, $p = 0.03$), compared to those without diabetes, adjusting for age, hemoglobin level, estimated-glomerular-filtration-rate, admission specialty unit, Charlson's comorbidity index score, and glucocorticoid exposure. No significant differences were observed in ICU admission, 30-day/18-month readmission, and 18-month mortality among patients with known, previously unrecognized and no diabetes ($p \geq 0.05$).

Conclusions: Approximately one in five hematology or oncology inpatients aged ≥54 years had known diabetes, and one in fourteen had previously unrecognized diabetes. Those with known diabetes had a longer hospital stay. Routine HbA1c measurement is can be

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https://doi.org/10.1016/j.diabres.2019.05.002

useful for identifying previously unrecognized diabetes, particularly among patients with high glucocorticoid exposure. Further study is required to determine cost-effectiveness in screening for unrecognized diabetes and optimal management of these patients.

1. Introduction

Inpatient hyperglycemia is associated with increased mortality and morbidity [1]. Among hematology and oncology patients with or without known history of diabetes mellitus, hyperglycemia [impaired or abnormal fasting glucose of 100 to <126 mg/dL (5.6 to <7.0 mmol/L) or ≥126 mg/dL (≥7.0 mmol/L), respectively] is associated with poorer outcomes including shorter complete remission, and increased risk of complicated infection and mortality [2–5].

The exact mechanisms that associate diabetes with cancer is not completely understood. However, studies have suggested that hyperglycemia, hyperinsulinemia and inflammation being a potential link between diabetes and cancer development [6]. For instance, epidemiological data has shown that increased glycated hemoglobin levels (HbA1c) being related to increased risk of colorectal cancer and gastric and pancreatic cancer [7]. Hyperinsulinemia has also been found to be associated with the development of kidney, bowel, colon and breast cancers [8–10]. Activation of the insulin pathway, the insulin-like growth-factor pathway, and dysregulation of endogenous sex hormones are pathways which may link diabetes and breast cancer [11]. The presence of high body mass index (defined as greater than or equal to 25 kg/m^2), insulin resistance, glucose toxicity, and chronic low-grade inflammation certainly appear to be key players between diabetes and cancer progression (including pancreatic, liver, colorectal, breast, and endometrial cancers) [12–16].

Glucocorticoids are often used as chemotherapy adjuncts and symptomatic measures in treating hematological and oncological conditions. In virtually all patients with known diabetes, glucocorticoids exacerbate hyperglycemia [17–19]. Studies found that patients on glucocorticoid therapy have up to doubled risk of developing diabetes overall [20–22]. A recent study found that patients with hematologic malignancies treated with glucocorticoids had a prevalence of hyperglycemia of almost 40 percent [23]. Overall, there is a lack of data in the literature regarding prevalence of diabetes in hematology and oncology patients, despite the high likelihood of glucocorticoid exposure.

This prospective, observational study aimed to estimate the prevalence of diabetes, both known and previously unrecognized, among hematology and oncology inpatients, and to compare hospital outcomes between those with and without diabetes. We hypothesized that hematology and oncology patients with known and previously unrecognized diabetes have poorer hospital outcomes, compared to those without diabetes.

2. Subjects

All patients aged ≥54 years admitted to hematology and oncology units at Austin Health, a tertiary teaching hospital, during the study period (17/7/2013–17/1/2015) were eligible for this prospective observational study. Age cut-off of ≥54 years was chosen due to the high prevalence of unrecognized diabetes in hospitals in this age group [24].

3. Methods

As part of routine care, patients underwent HbA1c testing coordinated via an automated order through Cerner® Millennium IT Health Platform on admission if no HbA1c result recorded on the system within the last 90 days [25]. All HbA1c results were reported via Cerner®, accessible by patients' treating doctors. Patients aged <54 years, those admitted to day oncology, dialysis and palliative care units, and those with HbA1c results available on the system in the last 90 days were excluded from routine HbA1c testing.

Ethylenediaminetetraacetic acid whole blood was collected from patients for analysis [25]. HbA1c was measured by turbidimetric inhibition immunoassay (TINIA) on Cobas Integra 800 (Roche Diagnostics, Mannheim, Germany) [25]. The assay was standardized to the International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) reference method which had a between-run co-efficient of variation 2.5% for HbA1c 30 mmol/mol (5.6%) and 1.5% for HbA1c 83 mmol/mol (9.7%) [25].

From medical records and hospital databases, pre-specified demographic data, clinical characteristics (age, gender, and smoking status) and medical history including information regarding comorbidities (to calculate Charlson's comorbidity index scores, excluding diabetes component) [25] were obtained. Extracted and analyzed data included (i) biochemical laboratory values: HbA1c, hemoglobin level (Hb), serum creatinine and estimated-glomerular-filtration-rate using Chronic Kidney Disease Epidemiology Collaboration equation (CKD-EPI-eGFR) [26]; (ii) data on glucocorticoid exposure (up to 365 days prior to index admission); and (iii) hospital outcomes: length-of-stay (LOS) (i.e. number of days spent in the hospital), intensive-care-unit (ICU) admission, 30-day and 18-month readmission, and 18-month mortality [25].

Patients were categorized into three groups: (i) "*Known diabetes*" where a diagnosis of diabetes was documented regardless of HbA1c results; (ii) "*Unrecognized diabetes*" where no diagnosis of diabetes was documented and HbA1c was ≥48 mmol/mol (6.5%); and (iii) "*No diabetes*" where no diagnosis of diabetes was documented and HbA1c was <48 mmol/mol (6.5%).

Index admission was defined as a patient's first hospital admission during the 18-month study period. 30-day or 18-month readmission were defined as repeat admission back to (any units of) the hospital within 30 days or 18 months after index admission. 18-month mortality data was collected for patients that were noted as 'deceased' during the study period.

3.1. Statistical analyses

Patient groups were compared with respect to baseline characteristics. Continuous variables were summarized as medians with interquartile ranges (IQR), and distributions compared using Wilcoxon-Mann-Whitney Rank Sum test or Kruskal-Wallis test as appropriate. Categorical variables were reported as proportions and compared with χ^2 tests or Fisher's Exact test as appropriate.

The association between diabetes status (known/unrecognized/no diabetes) and hospital outcomes were examined, after adjustments for baseline characteristics including age, Hb, CKD-EPI-eGFR, admission specialty unit (hematology or oncology), Charlson's comorbidity index score (excluding diabetes component) and glucocorticoid exposure [1,25], using negative binomial regression for LOS and logistic regression for binary outcomes. Respective effects were summarized as Incidence Rate Ratio (IRRs) and Odds Ratios (ORs) with corresponding 95% confidence intervals (95%CI). IRRs represented a factor change in expected LOS for patients with known or unrecognized diabetes, compared to patients without diabetes. All *p*-values were calculated from two tailed tests of statistical significance and *p*-values ≤ 0.05 were considered statistically significant. All analyzes were performed with STATA Version13.0 (STATACorp, Texas, USA).

This study was approved by Austin Health Research Ethics Committee (LNR/15/Austin/41), who waived the need for informed consent for a planned practice change agreed to by the hospital senior medical staff as part of the Austin Health Diabetes Discovery Initiative [25].

4. Results

One thousand and seventy-six inpatients aged ≥54 years were admitted over the 18-month study period with 298 and 778 patients in hematology and oncology units, respectively (Supplemental Table S1). Of the 1076 patients, 21% (95%CI: 19–24%) had known diabetes and 7% (95%CI: 6–9%) had previously unrecognized diabetes based on routine HbA1c ≥ 48 mmol/mol (6.5%) and medical records (Fig. 1), giving a total of 28% (95%CI: 25–31%) with diabetes.

4.1. Baseline characteristics

The baseline characteristics of patients with known diabetes, previously unrecognized diabetes, and no diabetes are shown in Table 1. Age, Hb and CKD-EPI-eGFR differed significantly between the three groups of patients (Table). Patients with diabetes (known and unrecognized) were significantly older, with lower Hb and lower CKD-EPI-eGFR, compared to those without diabetes (Table 1). Overall, 12% of patients with diabetes (known or unrecognized) had HbA1c ≥ 69 mmol/mol (8.5%).

4.1.1. Glucocorticoid exposure

Forty-three percent (467/1076; 95%CI: 40–46%) of the cohort had glucocorticoid exposure within the last 365 days prior to their index admissions. No significant difference was observed in the proportions of glucocorticoid exposure among those with known/unrecognized/no diabetes (Table 1). Among those with previously unrecognized diabetes, 42% (30/71; 95%CI: 31–55%) had previous glucocorticoid exposure

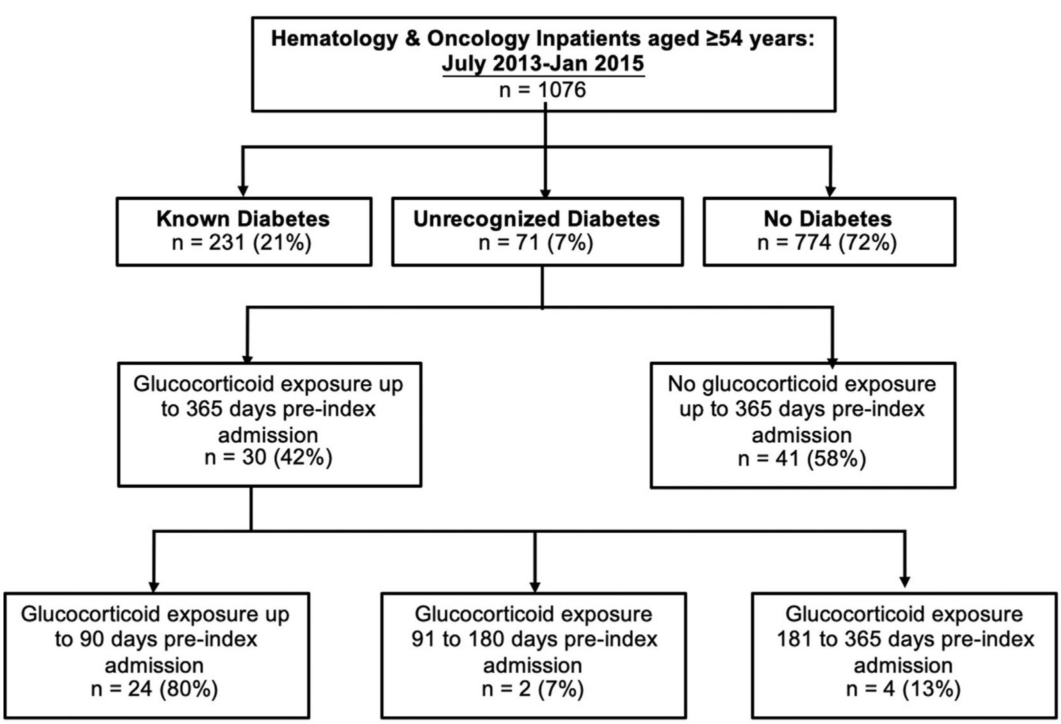

Fig. 1 – Prevalence of diabetes mellitus among hematology and oncology inpatients aged ≥54 years.

Table 1 – Baseline characteristics of 1076 hematology and oncology inpatients by diabetes status.

	Known Diabetes	Unrecognized Diabetes	No Diabetes	*p*-value
Number (n)	231	71	774	–
Age (years)	71 (64–77)	71 (64–77)	68 (62–75)	**0.003***
Men (%)	59.7	59.2	58.3	0.93†
Smokers (%)	26.4	33.8	33.9	0.10†
HbA1c (mmol/mol)	51.9 (45.4–62.8)	50.8 (48.6–53.0)	38.8 (35.5–42.1)	–
HbA1c (%)	6.9 (6.3–7.9)	6.8 (6.6–7.0)	5.7 (5.4–6.0)	–
Hemoglobin level (g/L)	113 (95–129)	106 (93–123)	117 (99–133)	**0.002***
CKD-EPI-eGFR (ml/min/1.73 m^2)	73 (51–90)	78 (58–92)	82 (62–94)	**0.005***
Glucocorticoid exposure (%)	38.5	42.3	45.0	0.22†
Charlson's index score	2 (0–4)	2 (0–3)	2 (0–3)	0.37*

Continuous variables are reported as medians with interquartile ranges in parentheses, using *Kruskal-Wallis test between known diabetes, unrecognized diabetes and no diabetes. Categorical variables are reported as percentages (%), using †Fisher's exact test between known diabetes, unrecognized diabetes and no diabetes. Abbreviations: Hem = hematology Unit; Onc = oncology Unit; CKD-EPI = Chronic kidney disease-epidemiology collaboration equation; eGFR = estimated glomerular filtration rate; Glucocorticoid exposure = Glucocorticoid exposure up to a year before index admission; Charlson's index score = Charlson's comorbidity index score (excluding diabetes component).

within the last year, 80% of which (24/30; 95%CI: 61–92%) were within the last 90 days of their index admissions (Fig. 1).

4.2. *Hospital outcomes based on diabetes status*

The 18-month unadjusted hospital outcomes are presented in Table 2. The associations of diabetes with hospital outcomes, after adjusting for baseline characteristics (age, HbA1c, CKD-EPI-eGFR, admission specialty units, Charlson's comorbidity index score and glucocorticoid exposure), are presented in Table 3 and Fig. 2.

4.2.1. *Length-of-Stay (LOS)*

After adjusting for baseline characteristics, patients with known diabetes had longer LOS than those without diabetes. No significant difference was observed in LOS between patients with unrecognized diabetes and no diabetes (Table 3 and Fig. 2a).

4.2.2. *Intensive-Care-Unit (ICU) admission*

No significant differences were observed in the proportions of ICU admission between patients with known diabetes and no diabetes, nor between those with unrecognized diabetes and no diabetes, after adjustments for baseline characteristics (Table 3 and Fig. 2b).

4.2.3. *30-day or 18-month readmission*

No significant differences were observed in the proportions of 30-day or 18-month readmission between patients with known diabetes and no diabetes, nor between those with unrecognized diabetes and no diabetes, after adjustments for baseline characteristics (Table 3 and Fig. 2c & d).

4.2.4. *18-month mortality*

No significant differences were observed in the proportions of 18-month mortality between patients with known diabetes and no diabetes, nor between those with unrecognized diabetes and no diabetes, after adjustments for baseline characteristics (Table 3 and Fig. 2e).

4.3. *Hospital outcomes in hematology versus oncology patients*

After adjusting for baseline characteristics and diabetes status, oncology patients in the cohort had on average twice shorter expected LOS (IRR: 0.5, 95%CI: 0.4–0.6; $p < 0.001$), and were less likely to be admitted to ICU (OR: 0.1, 95%CI: 0.04–0.4, $p < 0.001$), compared to their hematology counterparts. However, they also had twice as high the odds of dying within an 18-month period (OR: 2.0, 95%CI: 1.3–2.9, $p = 0.001$), compared to their hematology counterparts. No significant differ-

Table 2 – 18-month unadjusted hospital outcomes.

	Known and Unrecognized Diabetes	Known Diabetes	Unrecognized Diabetes	No Diabetes	*p*-value
Number (n)	302	231	71	774	–
LOS (days) (Median, IQR)	5 (2–11)	5 (2–13)	4 (2–10)	5 (2–10)	0.35*
ICU admission (%)	3.3 (1.3–5.3)	3.0 (1.3–5.2)	4.2 (0.0–9.9)	3.8 (2.3–5.2)	0.81†
30-Day Readmission (%)	27.8 (22.8–32.8)	27.3 (21.2–33.3)	29.6 (18.3–40.8)	26.7 (23.6–29.8)	0.86†
18-Month Readmission (%)	57.3 (51.7–62.9)	55.4 (48.9–61.9)	63.4 (52.1–74.6)	55.7 (51.9–59.3)	0.45†
18-Month Mortality (%)	41.1 (35.1–46.7)	39.8 (34.2–46.3)	45.1 (33.8–57.7)	39.7 (36.3–43.0)	0.67†

Continuous variables are reported as medians with interquartile ranges in parentheses, using *Kruskal-Wallis test between known diabetes, unrecognized diabetes and no diabetes. Categorical variables are reported as percentages (%) with 95%CI in parentheses, using †Fisher's exact test between known diabetes, unrecognized diabetes and no diabetes. Abbreviations: LOS = Length-of-stay; ICU = Intensive-care-unit.

Table 3 – Associations of diabetes status with hospital outcomes over 18-month period after adjustments.*

	Known Diabetes compared to No Diabetes			Unrecognized Diabetes compared to No Diabetes		
	IRR/OR	95%CI	*p*-value	IRR/OR	95%CI	*p*-value
LOS (days)	1.18	1.02–1.37	0.03	0.85	0.67–1.09	0.21
ICU Admission	0.69	0.29–1.65	0.40	1.32	0.38–4.6	0.66
30-Day Readmission	1.05	0.75–1.47	0.78	1.16	0.68–1.99	0.59
18-Month Readmission	1.03	0.76–1.39	0.85	1.40	0.84–2.34	0.19
18-Month Mortality	0.93	0.67–1.29	0.65	1.16	0.68–1.99	0.58

* Adjusted for age, hemoglobin level, CKD-EPI-eGFR, admission specialty units (hematology or oncology), Charlson's comorbidity index score (excluding diabetes component) and glucocorticoid exposure. Negative binomial regression was used for length-of-stay; while logistic regression was used for binary outcomes. Abbreviations: LOS = Length-of-stay; ICU = Intensive-care-unit; IRR = Incidence Rate Ratio (applicable to continuous variables, i.e. LOS); OR = Incidence Ratio (applicable to categorical variables, i.e. ICU admission, 30-day readmission, 18-month readmission, and 18-month mortality).

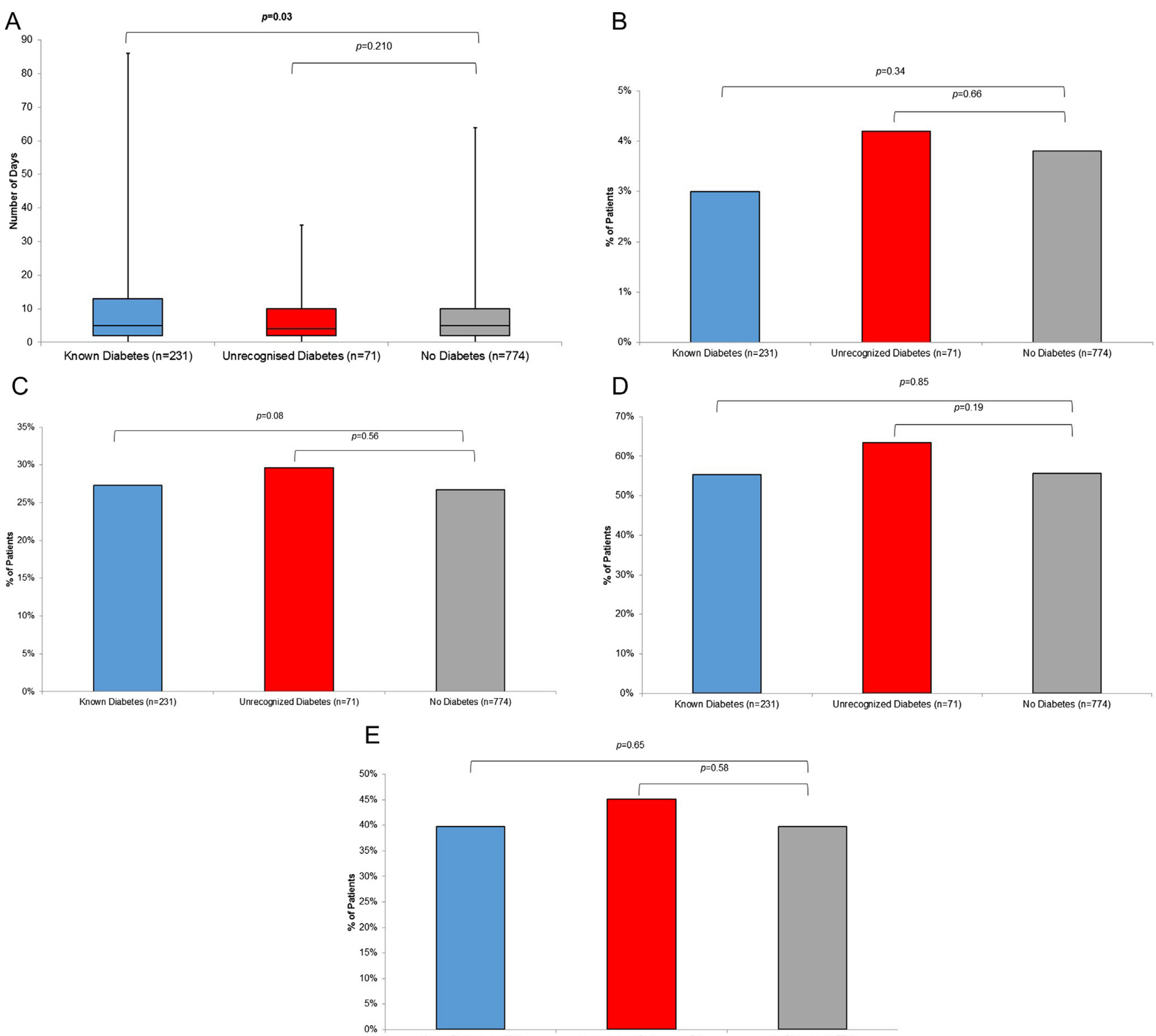

Fig. 2 – Associations of diabetes status with hospital outcomes over the 18-month period: (a) length-of-stay, (b) intensive-care-unit admission (c) 30-day readmission, (d) 18-month readmission, and (e) 18-month mortality, with adjustment for age, hemoglobin level, estimated-glomerular-filtration-rate (CKD-EPI), admission specialty units (hematology or oncology), Charlson's comorbidity index score (excluding diabetes component) and glucocorticoid exposure. (a). Length-of-stay. (b). Intensive care unit admission. (c). 30-day readmission. (d). 18-month readmission. (e). 18-month mortality.

ences were observed in the proportions of 30-day/18-month readmission between oncology and hematology inpatients.

5. Discussion

The aim of this study was to examine the prevalence of known and unrecognized diabetes among hematology and oncology inpatients and their hospital outcomes utilizing automated routine HbA1c testing. We found that 21% had known diabetes, and 7% had previously unrecognized diabetes. After adjusting for baseline characteristics, patients with known diabetes had longer LOS, compared to those without diabetes. However, no differences in hospital outcomes were observed between patients with unrecognized and no diabetes.

5.1. *Prevalence of diabetes*

The prevalence of diabetes among hematology and oncology patients has not been well studied. In a 10-year study (1999–2008) in a cancer center, the prevalence of diabetes was found to be 6.8% (1,090/15,951) [27], compared to a total of 28% (95% CI: 25–31%) in our cohort. In that study, the diagnosis of diabetes was established by linking electronic files which required documentation of diabetes that may be prone to ascertainment bias [27], and the analysis was restricted to solid tumors. As our study population targeted older patients (≥54 years) and as prevalence of diabetes increases with age [24], this may have led to the large discrepancy in reported prevalence of diabetes among cancer patients. No previous studies have utilized routine HbA1c testing among hematology and oncology inpatients (often with glucocorticoid exposure), to detect previously unrecognized diabetes, as in our study. We found 7% (95%CI: 6–9%) of hematology and oncology inpatients had previously unrecognized diabetes, which is higher than the prevalence of 5% detected by Simpson et al. among general inpatients aged over 54 years [24]. Such a high rate of unrecognized diabetes detected in our cohort may be attributed to their high glucocorticoid exposure.

5.1.1. *Glucocorticoid exposure*

The prevalence of glucocorticoid use is very high among hematology and oncology inpatients that 43% (95%CI: 40–46%) had glucocorticoid exposure within the last year prior to their index admissions. This figure is likely to be an underestimation, as it did not include glucocorticoid prescriptions given out in the outpatient settings or externally (e.g. private hospitals and general practices). Among those with unrecognized diabetes, a third had glucocorticoid exposure within the last three months of their index admissions. Previous studies showed that oral glucocorticoid therapy is associated with increased new-onset diabetes risk (OR: 1.4–2.3) [21,28]. Thus, many of these previously unrecognized diabetes may be related to glucocorticoid exposure. However, due to patients' unknown diabetes status *prior to* exposure, the exact rate of glucocorticoid-induced diabetes could not be ascertained. Nevertheless, such a high prevalence of unrecognized diabetes is important to recognize among this particular group of patients given their frequent glucocorticoid exposure, often as part of chemotherapy regimens or peri-chemotherapy for symptomatic control. Given the significant impact glucocorticoids have on plasma glucose, HbA1c testing can be used routinely to identify those at increased risk of severe complications related to glucocorticoid-induced hyperglycemia such as hyperosmolar-hyperglycemic-state. Knowing what their HbA1c is at the time of glucocorticoid commencement helps raise awareness of those high risk patients so that diabetes education is initiated earlier. Further, HbA1c testing has the advantage of no fasting required, and being less influenced by stress hyperglycemia if used in the hospital settings.

As these hematological or oncological patients may be struggling to deal with two complex conditions [27], poor adherence to diabetes treatment may have contributed to the overall poor glycemic control in our cohort [12% with HbA1c ≥ 69 mmol/mol (8.5%)], but glucocorticoid related hyperglycemia may certainly play a role. As indicated in our previous study [25], these patients received routine review by an endocrinology team whilst inpatient (although the direct effect of such intervention was not specifically analyzed).

5.2. *Hospital outcomes*

After adjusting for baseline characteristics, patients with known diabetes had longer LOS (IRR: 1.2, 95%CI: 1.0–1.4, $p = 0.03$), compared to those without diabetes. This is as expected given the complexities of diabetes as a condition stand-alone [1]. The lack of such finding among those with unrecognized diabetes may be related to the relatively small sample size (n = 71). Compared to their hematology counterparts, we also found that oncology patients had shorter LOS but higher odds of dying. This may be associated with the more aggressive nature of their oncological conditions, although data on specific types of oncological conditions were not analyzed.

A large retrospective study in the hospital setting by Eby et al. [29] reported that having type 2 diabetes was one of the strongest predictors of readmission within 30 days [29], and patients with diabetes had more readmission than those without diabetes. The lack of similar findings in our cohort may be explained by our relatively small sample sizes of known (n = 231) and unrecognized (n = 71) diabetes, compared to the retrospective study of >50,000 patients.

Fluctuations in plasma glucose concentrations have been associated with increased cardiovascular mortality [30] and cancer death [5]. Even short-term or postprandial hyperglycemia is associated with acute inflammation and endothelial dysfunction in patients with and without type 2 diabetes [31]. We found no significant differences, however, in the proportions of mortality over an 18-month period between those with diabetes (known or unrecognized) and without diabetes, similar to other studies [32–34]. It is likely that those who progressed and died during the study period may be related to the overall more aggressive nature of their underlying conditions. Nevertheless, data on specific types of hematological/oncological conditions were not analyzed, and mortality data in our study may be incomplete, as not all deaths in the community may have been notified to the hospital.

Although the benefits of improving glycemic control in hematology and oncology patients have not been established in clinical trials, it would seem reasonable to reduce marked hyperglycemia and hence associated complications including infection and lethargy to improve the quality of life of these patients with often guarded prognosis [27].

To our knowledge, this study is the first reported large-scale initiative using routine automated HbA1c testing to assess the prevalence of known and unrecognized diabetes among hematology and oncology inpatients. Routine HbA1c testing helps raise awareness of those at high risk of glucocorticoid-induced hyperglycemia. By targeting those at risk, simple measures such as education regarding symptoms of hyperglycemia, initiation of oral hypoglycemic agents such as metformin (which may have some anti-cancer effects [35,36]), could be implemented earlier to avoid severe complications of hyperglycemia that require hospitalizations later, for example hyperglycemic hyperosmolar crises. This could potentially reduce hospital stay and readmission rates associated with severe hyperglycemia. Further study is required to investigate the effectiveness of having diabetes educators dedicated to hematology and oncology patients given their frequent glucocorticoid exposure.

We acknowledge that the diabetes epidemiology among hematology and oncology inpatients may be different compared to the general population, and the use of age cut off being ≥54 may not be transferrable to cancer patients. Further, our study was conducted in a tertiary hospital in a metropolitan area, and thus, may not be generalizable to populations in non-metropolitan area. Nonetheless, our study examined a large data set over a long period of 18 months, and provided the first glimpse of detailed information about the prevalence of known and previously unrecognized diabetes among hematology and oncology patients aged ≥54 in a tertiary hospital setting. It would have been interesting to see what the prevalence of diabetes is among all admitted cancer patients had the hospital resources (e.g. cost of testing, cost and time involved in blood sample collections, follow up of results, etc.) not been a limiting factor.

Certain patient variables such as body mass index and ethnicity (e.g. Pacific Islanders and South Asians have increased rates of diabetes [37]), diabetes history, family history, previous history of gestational diabetes mellitus, specific type of oncology or hematology conditions, and details of concomitant use of diabetogenic medications (e.g. atypical antipsychotic) or anticancer therapies (e.g. Everolimus, a mammalian targets of rapamycin (mTOR) inhibitor, and Nilotinib, a tyrosine kinase inhibitors (TKI)) [38,39] were not available for analysis. We acknowledge that any of these variables are potential risk factors for the development of diabetes [40] and may affect the outcomes of the study. Additionally, although 7% of patients were identified with previously unknown diabetes among our study population, we acknowledge that the use of HbA1c alone may underestimate the real prevalence of diabetes among hematology and oncology inpatients. For instance, HbA1c would not have been accurate in patients with significant anemia, increased red cell turnover, or hemoglobinopathy [40]. It has thus been suggested that diabetes prevalence may be more accurately defined by blood glucose levels (particularly 2-h post-prandial levels among patients on glucocorticoid therapy) as well as HbA1c rather than HbA1c alone. This is because glucocorticoid therapy may induce acute hyperglycemia which may not be detected by HbA1c [40,41].

To conclude, among hematology and oncology inpatients aged ≥54 years, one in five had known diabetes while one in fourteen had previously unrecognized diabetes, many of whom with recent glucocorticoid exposure. Patients with known diabetes had prolonged hospital stays. Routine HbA1c testing, can be useful in identifying those with previously unrecognized diabetes; and, along with blood glucose testing, among those at risk of glucocorticoid-induced hyperglycemia and associated complications. The primary concern is not only the optimal pharmacologic approach to glycemic control but also to ensure the best quality of life for these patients with often guarded prognosis. Examination of treatment responsiveness and quality of life differences between patients with and without diabetes in hematology and oncology settings remain an important area for future investigation.

Acknowledgements

The authors are grateful to Peter Davey (Department of Administrative informatics, Austin Health) for assistance with data retrieval and information technology support.

Declaration of interest

There are no conflicts of interest to declare.

Funding

A/Prof Ekinci was supported by an Australian National Health and Medical Research Council (NHMRC) Early Career Fellowship, Viertel Clinical Investigatorship, Royal Australasian College of Physicians (RACP) Fellowship and Sir Edward Weary Dunlop Medical Research Foundation Research Grant.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.diabres.2019.05.002.

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