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Authors

Moffet, Howard
Huang, Elbert
Liu, Jennifer
et al.

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Severe hypoglycemia and falls in older adults with diabetes: The Diabetes & Aging Study

Howard H. Moffet, MPH[a,*], **Elbert S. Huang, MD, MPH**[b], **Jennifer Y. Liu, MPH**[a], **Melissa M. Parker, MS**[a], **Kasia J. Lipska, MD, MHS**[c], **Neda Laiteerapong, MD, MS**[b], **Richard W. Grant, MD, MPH**[a], **Alexandra K. Lee, PhD, MSPH**[d], **Andrew J. Karter, PhD**[a]

[a]Kaiser Permanente Division of Research, 2000 Broadway, Oakland, CA 94612

[b]University of Chicago, 5841 S. Maryland Avenue, Chicago, IL 60637

[c]Yale University School of Medicine, PO Box 208020, New Haven, CT 06520

[d]Division of Geriatrics, University of California, 4150 Clement St, VA181G, San Francisco, CA 94121

Abstract

Objective: To estimate rates of severe hypoglycemia and falls among older adults with diabetes and evaluate their association.

Research Design and Methods: Survey in an age-stratified, random sample adults with diabetes age 65–100 years; respondents were asked about severe hypoglycemia (requiring assistance) and falls in the past 12 months. Prevalence ratios (adjusted for age, sex, race/ethnicity) estimated the increased risk of falls associated with severe hypoglycemia.

Results: Among 2,158 survey respondents, 79 (3.7%) reported severe hypoglycemia, of whom 68 (86.1%) had no ED visit or hospitalization for hypoglycemia. Falls were reported by 847 (39.2%), of whom 745 (88.0%) had no fall documented in outpatient or inpatient records. Severe hypoglycemia was associated with a 70% greater prevalence of falls (adjusted prevalence ratio = 1.7 (95% CI, 1.3–2.2)).

Conclusion: While clinical documentation of events likely reflects severity or care-seeking behavior, severe hypoglycemia and falls are common, under-reported life-threatening events.

Twitter:

Among older adults with diabetes, severe hypoglycemia is associated with 70% greater risk of falls; both are common, under-reported life-threatening events.

[*]corresponding author.

Author Contributions and Guarantor Statement.

HHM, ESH, JYL, MMP, KJL, NL, RWG and AJK designed the survey. HHM, JYL and MMP researched the data. HHM, JYL and AJK wrote the first draft of the manuscript. All authors reviewed and edited the manuscript. All authors approved the final version of the manuscript.

HHM. is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Conflicts of interest

The authors have no conflicts of interest.

Keywords

diabetes mellitus; aging; falls; survey; patient-reported outcomes

Severe hypoglycemia is a known risk factor for falls in older adults with diabetes,[1] and falls are a leading cause of morbidity and mortality in older adults.[2] The Atherosclerosis Risk in Communities (ARIC) study among middle aged adults with type 2 diabetes found that severe hypoglycemia was associated with a more than twofold higher risk of falls,[3] but that study relied on documented events from claims and medical record data which underestimate the true incidence of both severe hypoglycemia episodes and falls. Only about 10% of falls[4] (mostly falls which result in injury) and 5% of severe hypoglycemia events[5] (resulting in an emergency department (ED) visit or hospitalization) are captured in electronic health records (EHRs). It is unknown whether underestimates of severe hypoglycemia and falls may have biased any observed associations.

Using data from patient surveys and the EHR, this study examined the hypotheses that severe hypoglycemia and falls are underascertained in the EHR and that severe hypoglycemia will be confirmed as a risk factor for falls based on patient report.

METHODS

The Diabetes and Aging Study conducted the Diabetes Preferences and Self-Care Survey in 2019 among older patients with diabetes who were members of Kaiser Permanente Northern California (KPNC), an integrated healthcare delivery system. The KPNC Diabetes Registry, a large, diverse, real-world population, has been followed longitudinally since its inception in 1994. Demographic and clinical data were obtained from the KPNC EHR. The study sampling frame (N=132,103) included members who were 65–100 years of age as of 1/1/2019, living in the KPNC service area and whose preferred written language was English, Spanish or Chinese. Subjects were excluded if they had a diagnosis of cognitive impairment or were not community dwelling.

An age-stratified (65–74, 75–84, 85–100 years of age), random sample (N=6,000, 50.5% female) was invited to participate in the survey which sought patient-reported data that are not routinely captured in an EHR: treatment preferences, self-management barriers and patient-reported outcomes. A written survey was mailed to each subject in their preferred language (English (n=5,505), Spanish (n=314) and Chinese (n=181)) with an option to complete the survey by telephone interview or online in their preferred language.

The outcome of interest was self-reported number of falls from the survey: “In the past 12 months, how many times have you fallen?” with response options: Never, Once, Two times or more. Falls were identified from the EHR during 2018 based on outpatient, ED or hospital diagnosis using ICD10 codes W00-W19 for “Slipping, tripping, stumbling and falls.”

The exposure of interest was self-reported severe hypoglycemia from the survey: “In the past 12 months, have you had low blood sugar that resulted in passing out or needing help from

someone else? (For example, you were unable to treat yourself, were unconscious or were given glucagon or intravenous glucose).” Severe hypoglycemia was identified from the EHR during 2018 based on primary diagnosis of hypoglycemia in the ED or principal diagnosis in the hospital.[6]

Negative binomial regression models with expansion weights for the age-stratified sampling design were specified to calculate rates and prevalence ratios (PR)(adjusted for age, sex, race/ethnicity) of falls (outcome) and severe hypoglycemia. Interaction terms (i.e., severe hypoglycemia x insulin; severe hypoglycemia x sulfonylurea) were added to test whether use of hypoglycemia-prone medications modified the relationship between severe hypoglycemia and falls.

This study was approved by the Kaiser Permanente Northern California (KPNC) Institutional Review Board.

RESULTS

Surveys were completed by 2,246 participants during early 2019. Returned mail identified 485 ineligible subjects (denied having diabetes (n=351), mail returned undeliverable (n=58), left KPNC (n=34), deceased (n=34), language barriers or not competent to participate (n=8)) for an adjusted response rate of 40.7% (2,246/5,515). Among 2,158 survey respondents who answered the survey question about falls, the mean (SD) age was 78.9 (7.7) years and 1,008 (46.7%) were female (Table 1).

Severe hypoglycemia (requiring assistance) in the past 12 months was reported by 79 (3.7%) respondents, of whom 68 (86.1%) had no documented ED visit or hospitalization for hypoglycemia (among those who reported no severe hypoglycemia, 9 in fact had an ED visit or hospitalization for hypoglycemia). Severe hypoglycemia rates did not differ by age strata (p=.874).

Falls in the previous 12 months were reported by 847 (39.2%), of whom 745 (88.0%) had no documented fall in the EHR (among those who reported having no falls, 27 in fact had a documented fall). Rates increased with age (p<.001): 48.3% of respondents age 85–100 years reported at least one fall.

Based on weighted negative binomial regression analysis, the rate of falls among participants who reported severe hypoglycemia was 92.4 (95% CI 73.5–116.2) per 100 person-years (100py) compared to 52.6 (95% CI 49.5–55.9) per 100py among those who reported no severe hypoglycemia. Severe hypoglycemia (compared to no severe hypoglycemia) was associated with a higher risk of falls: the crude prevalence ratio (PR) was 1.8 (95% CI 1.4–2.2); after adjustment for age, sex and race, hypoglycemia was associated with a 70% greater prevalence of falls (PR = 1.7 (95% CI, 1.3–2.2); p<.0001). The relationship between severe hypoglycemia and falls was not modified by use of hypoglycemia-prone medications (interactions with insulin and sulfonylurea were non-significant (p=.14 and p=.88, respectively).

DISCUSSION

In older adults with diabetes, severe hypoglycemia is common and associated with falls. The association between self-reported hypoglycemia and falls (PR = 1.7 (95% CI, 1.3–2.2) was similar to the effect estimate based on clinically documented hypoglycemia and falls in the ARIC Study (hazard ratio: 2.2; 95% CI 1.6–3.1).[3] A comparison of patient self-report and EHR data suggests that >86% of severe hypoglycemia events are treated outside the health care system and >88% of falls do not require medical attention. While clinical documentation likely reflects event severity or care-seeking behavior, severe hypoglycemia and falls are common, serious and potentially life-threatening events. Severe hypoglycemia is associated with tripling of the risk of mortality,[7,8] as well as substantial increases in dementia and cognitive decline,[9,10] stroke,[11] falls,[3,12,13] and cardiovascular events.[14] Falls are a leading cause of morbidity and mortality in older adults.[2] Given the observed association between severe hypoglycemia and falls, they both deserve attention.

It is important to consider fall risk when setting glycemic goals; the American Diabetes Association recommends screening older adults for severe hypoglycemia and geriatric conditions, including fall history, as these may affect diabetes self-management and diminish quality of life.[15,16] Since 2011, Medicare beneficiaries are entitled to receive a free annual examination that requires a review of individual functional level and safety (including fall risk assessment), along with provision of personal prevention plan services.[17] Interventions to reduce hypoglycemia risk (e.g., modifying medication regimens or use of a continuous glucose monitor[18]) could reduce fall risk, and falls could be a prompt to ask about hypoglycemia.

Limitations & strengths

This study is limited by the survey response rate (40.7%), by survey implementation in a single health plan and by reliance on self-report in an older population. Accurate ascertainment of falls is difficult: patients may be unreliable in their recall or reporting of falls; most falls are non-injurious and go unreported or undocumented in the EHR.[19] Even falls resulting in injuries may escape recall: in the Health and Retirement Study, a nationally representative survey of older Americans (N=47,215), 72% of patients who received Medicare-reimbursed health care for fall-related injuries did not recall a fall injury when asked.[20] In the present study, among 129 participants who had a documented fall, 27 (20.9%) reported having none.

Several strengths can be noted. The use of self-reported data revealed the high prevalence of severe hypoglycemia and falls that are not documented in the EHR. The study population was racially and ethnically diverse, and oversampled the oldest participants (85–100 years of age) which allowed for accurate estimates of severe hypoglycemia and falls in this vulnerable age group.

CONCLUSIONS

Severe hypoglycemia and falls are common events in older adults with diabetes, and each are underascertained in the medical record. A patient’s history of severe hypoglycemia and

falls may be unknown unless queried and addressed at routine visits in older adults. While clinical documentation of events likely reflects severity or emergency care-seeking behavior, severe hypoglycemia and falls are common, serious, life-threatening events which should be assessed when evaluating older patients with diabetes.

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Abbreviations:

EHR	electronic health record
KPNC	Kaiser Permanente Northern California
ED	emergency department

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Article Highlights

- A survey of was conducted in an age-stratified, random sample of adults with diabetes age 65–100 years to estimate rates of severe hypoglycemia and falls and evaluate their association.
- Among 2,158 survey respondents, 79 (3.7%) reported severe hypoglycemia and 847 (39.2%) reported falls, but >85% had no corresponding event in their clinical record. Severe hypoglycemia was associated with a 70% greater prevalence of falls.
- Severe hypoglycemia and falls are common, serious, underdocumented life-threatening events which should be assessed when evaluating older patients with diabetes.

Table 1:

Characteristics of respondents (N=2,158) *

Age strata (years)	All	65–74	75–84	85–100	P-value
N (%)	N=2,158	702 (32.5%)	810 (37.5%)	646 (29.9%)	
Age, mean (SD), y	78.9 (7.7)	70.1 (2.8)	79.0 (2.8)	88.3 (2.8)	<.001
Female	1008 (46.7%)	315 (44.9%)	371 (45.8%)	322 (49.8%)	.15
Race/ethnicity †					
Asian	411 (19.0%)	151 (21.5%)	142 (17.5%)	118 (18.3%)	.13
Black	175 (8.1%)	53 (7.5%)	81 (10.0%)	41 (6.3%)	
Hispanic	255 (11.8%)	81 (11.5%)	92 (11.4%)	82 (12.7%)	
Other	126 (5.8%)	46 (6.6%)	43 (5.3%)	37 (5.7%)	
White	1191 (55.2%)	371 (52.8%)	452 (55.8%)	368 (57.0%)	
HbA1c (%), mean (SD)	7.11 (1.11)	7.15 (1.10)	7.17 (1.15)	7.00 (1.06)	0.010
Medications dispensed					
Insulin	572 (26.5%)	199 (28.3%)	236 (29.1%)	137 (21.2%)	.001
Sulfonylurea	787 (36.5%)	256 (36.5%)	305 (37.7%)	226 (35.0%)	.575
Hypertensive	1887 (87.4%)	615 (87.6%)	717 (88.5%)	555 (85.9%)	.325
Polypharmacy (≥4 medications)	1701 (78.8%)	547 (77.9%)	651 (80.4%)	503 (77.9%)	.394
Charlson score ≥4	1222 (56.6%)	293 (41.7%)	472 (58.3%)	457 (70.7%)	<.001
Self-reported severe hypoglycemia in past 12 months ‡	79 (3.9%)	25 (3.7%)	29 (3.8%)	25 (4.2%)	.874
ED visit or hospitalization for hypoglycemia during 2018	20 (0.9%)	6 (0.9%)	10 (1.2%)	4 (0.6%)	.463
Self-reported falls in past 12 months					
Never	1311 (60.8%)	476 (67.8%)	501 (61.9%)	334 (51.7%)	<.001
Once	506 (23.4%)	131 (18.7%)	190 (23.5%)	185 (28.6%)	
Two or more	341 (15.8%)	95 (13.5%)	119 (14.7%)	127 (19.7%)	
Falls recorded in EHR during 2018 §	129 (6.0%)	16 (2.3%)	50 (6.2%)	63 (9.8%)	<.001

*At or prior to survey date (baseline) or 01/01/2019

†Self-reported race and ethnicity from membership files, hospital records or surveys

‡Based on survey response to question, “In the past 12 months, have you had low blood sugar that resulted in passing out or needing help from someone else? (For example, you were unable to treat yourself, were unconscious or were given glucagon or intravenous glucose).”

§ICD-10 W00-W19