



# Administrative Coding Versus Laboratory Diagnosis of Inpatient Hypoglycemia

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Hypoglycemia is common and potentially life-threatening for patients with diabetes, often iatrogenic from diabetes treatments. It is important to accurately study rates of hypoglycemia in evaluating treatment of diabetes, but this can be challenging as many events are not reported. Difficulty with accurate reporting may also be present in the inpatient setting, where insulin administration is common to achieve glycemic targets (1). Discharge diagnosis codes show promise as a tool in the surveillance of hypoglycemic events in large administrative databases and have been used in many studies for that purpose (2–5). In this article, we describe the association of inpatient diagnosis codes with inpatient laboratory-measured hypoglycemia.

The study population for this retrospective cross-sectional study consisted of adults admitted to a Veterans Health Administration (VHA) hospital with an ICD-10-CM diabetes diagnosis code (E08–E13) from 2016 to 2022. One admission per patient was selected randomly for inclusion in this analysis. Information extracted from the medical record including demographics, outpatient comorbidity diagnostic codes, medications, and laboratory values are shown in Table 1. Hypoglycemia diagnosis was based on inpatient diagnostic codes for hypoglycemia. Those with a primary diagnosis of hypoglycemia were excluded, as it was assumed that those patients had hypoglycemia prior to presentation. Laboratory hypoglycemia was defined as point-of-care or venous blood glucose <70 mg/dL (3.89 mmol/L) and severe laboratory hypoglycemia as

<54 mg/dL (3.0 mmol/L), consistent with guideline recommendations (1).  $\chi^2$  testing was used to compare frequencies between groups. Logistic regression was used to analyze odds of 30-day and 1-year mortality, controlling for the covariates shown in Table 1 except for inpatient medications. This research was approved by the Stanford University institutional review board.

A total of 460,389 patients with diabetes were identified; 19,442 (4.2%) admissions were associated with a hypoglycemia inpatient diagnosis, 34,261 (7.4%) with laboratory hypoglycemia, and 11,199 (2.4%) with severe laboratory hypoglycemia. The sensitivity of a hypoglycemia diagnosis code was found to be 43.5% for severe laboratory hypoglycemia and 28.7% for laboratory hypoglycemia. Sensitivity was lower for those who received insulin during admission and higher for those not receiving insulin during admission, as shown in Table 1. A total of 24,430 patients had laboratory hypoglycemia without a discharge diagnosis code, while 6,326 had severe laboratory hypoglycemia without a discharge diagnosis code. Including laboratory and severe laboratory hypoglycemia increased identified hypoglycemic patients by 125.7% and 32.5%, respectively, compared with discharge diagnosis codes alone. Laboratory hypoglycemia was associated with adjusted odds ratio 2.15 (95% CI 2.15–2.15) for 30-day mortality and 2.05 (95% CI 1.99–2.10) for 1-year mortality.

Based on this analysis of a large, nationwide health care system, inpatient diagnosis code-based surveillance significantly

underestimates inpatient hypoglycemic events, missing 71.3% of patients with hypoglycemia and 56.5% with severe hypoglycemia by laboratory measurement. Blood glucose <70 mg/dL is typically treated with some intervention in the inpatient setting and could therefore be considered clinically significant. Additionally, laboratory hypoglycemia <70 mg/dL was associated with both short-term and long-term mortality in this study. Including laboratory measurements increased identified hypoglycemia by up to 125.7%, which is significant given the preventable nature of events. While only a small percentage of patients with no measured laboratory hypoglycemia were found to have hypoglycemia diagnosis codes, this accounted for 49.4% of patients with hypoglycemia diagnosis codes overall. A number of these diagnosis codes are likely false positives, although we are unable to rule out hypoglycemia prior to hospitalization that would not be detected by VHA laboratory measurements.

With this analysis we cannot determine the exact cause of the observed discrepancy between hypoglycemia diagnosis codes and laboratory measurements, but the discrepancy is likely related to lack of documentation by the medical team, as diagnosis codes are extracted by coding professionals in the inpatient setting. The finding that sensitivity is lowest for patients on insulin (the large majority of patients) may indicate that providers do not view such events as requiring documentation.

Inpatient hypoglycemia is important to monitor for potential harm from diabetes treatments, with implications for clinical

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**Table 1—Baseline characteristics and diagnostic performance**

	Glucose <54 mg/dL (n = 11,199)	Glucose <70 mg/dL (n = 34,261)	No laboratory glucose <70 mg/dL (n = 426,128)	P
Age, mean (SD)	71.3 (10.5)	71.1 (10.5)	69.8 (10.7)	<0.001
Male sex, n (%)	10,811 (96.5)	33,028 (96.4)	408,684 (95.9)	<0.001
Race/ethnicity, n (%)				<0.001
White	6,395 (57.1)	19,790 (57.8)	284,192 (66.7)	
Black	3,538 (31.6)	10,525 (30.7)	97,073 (22.8)	
Hispanic	935 (8.4)	2,919 (8.5)	30,821 (7.2)	
Asian	60 (0.5)	188 (0.6)	2,768 (0.7)	
Native American	104 (0.9)	312 (0.9)	4,225 (1.0)	
BMI, mean (SD)	27.9 (7.8)	28.4 (7.7)	31.0 (7.3)	<0.001
Hemoglobin A <sub>1c</sub> , mean (SD)	7.7 (2.0)	7.6 (2.0)	7.5 (1.9)	
eGFR, mean (SD)	57.6 (45.6)	59.6 (42.5)	70.1 (34.9)	<0.001
Hypertension, n (%)	9,952 (88.9)	30,441 (88.9)	376,138 (88.3)	0.001
Kidney disease, n (%)	5,062 (45.2)	15,043 (43.9)	123,096 (28.9)	<0.001
Heart failure, n (%)	4,253 (38.0)	12,573 (36.7)	118,936 (27.9)	<0.001
Liver disease, n (%)	1,972 (17.6)	5,638 (16.5)	56,533 (13.3)	<0.001
Malignancy, n (%)	2,542 (22.7)	7,460 (21.8)	84,451 (19.8)	<0.001
Outpatient medications, n (%)				
Insulin	7,418 (66.2)	21,788 (63.6)	209,186 (49.1)	<0.001
Sulfonylureas	2,298 (20.5)	7,227 (21.1)	104,430 (24.5)	<0.001
Metformin	3,192 (28.5)	10,596 (30.9)	204,279 (47.9)	<0.001
Inpatient medications, n (%)				
Insulin	8,791 (78.5)	25,876 (75.5)	286,415 (67.2)	<0.001
Sulfonylureas	683 (6.1)	2,465 (7.2)	30,817 (7.2)	0.799
Metformin	878 (7.8)	2,994 (8.7)	62,193 (14.6)	<0.001
Hypoglycemia diagnosis code, n (%)				
Inpatient insulin	4,873 (43.5)	9,831 (28.7)	9,611 (2.2)	<0.001
No inpatient insulin	3,078 (35.0)	5,639 (21.8)	6,201 (2.2)	<0.001
No inpatient insulin	1,795 (74.5)	4,192 (50.0)	3,410 (2.4)	<0.001

P values are in reference to comparisons between patients with glucose <70 and no glucose <70 mg/dL.

decision-making and system-level patient safety measures. Inpatient diagnosis codes are commonly used tools for surveillance of hypoglycemia admissions, as collection of this information is routine for administrative purposes and is much less costly compared with resource-intensive adjudication efforts. Based on this analysis, hypoglycemia monitoring at the systems level using inpatient diagnosis codes will significantly underestimate hypoglycemic events, and therefore additional measures such as laboratory surveillance should be used as well.

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