Changes in Management of Type 2 Diabetes Before and After Severe Hypoglycemia

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Severe hypoglycemia in patients with diabetes is an adverse drug event that is associated with poor outcomes, such as cardiovascular events, falls, high rehospitalization rates, and increased mortality (1,2). Several strategies, including adjustment of glucose-lowering therapy and glycemic targets, have been recommended in patients with severe hypoglycemia (1,3). However, it is not clear how changes in diabetes management are maintained after severe hypoglycemia among patients with type 2 diabetes.

We conducted a retrospective analysis of data from the OptumLabs Data Warehouse, a de-identified administrative claims database of over 200 million individuals enrolled in commercial and Medicare Advantage plans across the U.S. (4). Data were accessed in adherence with the Health Insurance Portability and Accountability Act of 1996, and the Yale School of Medicine Human Investigations Committee deemed the study exempt from institutional review board review.

We included commercially insured or Medicare Advantage beneficiaries who were aged 18 years or older, had pharmacologically treated type 2 diabetes, and had a severe hypoglycemic event. Severe hypoglycemia was identified as the first event during an observation window of 1 July 2013 through 30 June 2014, based on primary/principal diagnosis codes for hypoglycemia from an emergency department visit, observation stay, or hospital admission. We assessed changes in diabetes management by examining prescription fills for glucose-lowering medications, glucagon, and test strips; HbA_{1c} levels (on a subsample of patients); and outpatient care 6 months before and 6 months after the hypoglycemia-related health care utilization. We used paired two-sample *t* tests for continuous variables and McNemar test statistic for paired categorical variables in R software.

Among 5,721 patients with type 2 diabetes with severe hypoglycemia, median age was 69 years (interquartile range [IQR] 60–77), 51% were women, 63% were White, 20% were Black, 68% used insulin, and 37% used sulfonylureas. Of the 1,305 patients with available HbA_{1c} values, median baseline HbA_{1c} was 7.5% (range 4.3–17.6%). Changes in diabetes management are summarized in Table 1. The proportion of patients seeing an endocrinologist for diabetes management rose slightly from 16.7% to 18.2% but remained low. Only 30.5% of patients with a baseline HbA_{1c} $<6\%$ had an absolute increase in HbA_{1c} of at least 0.5% after hypoglycemia. Of the 905 patients filling prescriptions for both insulin and a sulfonylurea prior to severe hypoglycemia, 638 (70.5%) continued to fill both drug classes after the event. Glucagon was filled by fewer than 5% of patients.

In this national study of commercially insured and Medicare Advantage patients with type 2 diabetes who experienced a severe hypoglycemic event, the use of sulfonylureas declined, but few other changes in diabetes management were evident following the event. These findings suggest there are significant opportunities to prevent recurrent hypoglycemia in the future.

Multiple prior studies have demonstrated glycemic overtreatment among older patients at risk for hypoglycemia (5) and low rates of treatment deintensification. Our findings suggest that even after a severe hypoglycemic event, changes in management are infrequently made. Clinicians may have few options other than insulin in patients with long-standing diabetes and multiple comorbidities, and our study could not capture dose reductions in insulin that may have occurred. Still, most individuals with a low baseline HbA_{1c} did not have an increase in HbA_{1c} level after hypoglycemia, so any dose reductions were not reflected in the

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Table 1—Changes in diabetes management before and after hypoglycemia-related encounter

	6 months before	6 months after	*P* value
Office visits			
Number of office visits with any clinician	6 (3–9)	7 (4–11)	<0.001
Patients seeing an endocrinologist, *N* (%)	956 (16.7)	1,044 (18.2)	<0.001
Time to office visit after hypoglycemia (days)	—	12 (6–27)	
Diabetes self-management			
Patients with glucagon fills, *N* (%)	203 (3.55)	143 (2.50)	<0.001
Number of test strips filled per month	50 (16.7–91.7)	50 (33.3–108.3)	<0.001
Patients using continuous glucose monitoring, *N* (%)	96 (1.68)	53 (0.93)	<0.001
Glycemic control (n = 1,305)			
HbA_{1c} (%)	7.5 (6.6–8.9)	7.4 (6.5–8.7)	<0.001
Increase in HbA_{1c} by 0.5% or more (by baseline HbA_{1c}), *N* (%)			<0.001
<6% (n = 141)	—	43 (30.5)	
6–7% (n = 327)	—	93 (28.4)	
7–8% (n = 292)	—	62 (21.2)	
8–9% (n = 229)	—	40 (17.5)	
≥9% (n = 316)	—	31 (9.8)	
Patients with diabetes medication fills, *N* (%)			
Any insulin	3,864 (67.5)	3,967 (69.3)	<0.001
Human insulin	654 (11.4)	645 (11.3)	0.443
Analog insulin	3,494 (61.1)	3,661 (64.0)	<0.001
Basal insulin	2,895 (50.6)	3,111 (54.4)	<0.001
Bolus insulin	2,371 (41.4)	2,609 (45.6)	<0.001
Premixed insulin	786 (13.7)	727 (12.7)	0.010
Sulfonylureas	2,117 (37.0)	1,754 (30.7)	<0.001
Glinides	105 (1.8)	112 (2.0)	0.341
Biguanides	2,528 (44.2)	2,246 (39.3)	<0.001
TZDs	339 (5.9)	261 (4.6)	<0.001
DPP-4 inhibitors	819 (14.3)	784 (13.7)	0.055
GLP-1 agonists	260 (4.5)	218 (3.8)	<0.001
Other medications	213 (3.7)	211 (3.7)	0.904

Data are median (IQR) unless otherwise specified. DPP-4, dipeptidyl peptidase 4; GLP-1, glucagon-like peptide 1; TZDs, thiazolidinediones.

measured levels of glycemia. In addition, the low level of glucagon use suggests a missed opportunity to mitigate the risks of insulin use.

Our study has other limitations. It is an observational study, and as such we cannot make inferences about the appropriateness of individual clinical decisions reflected in these data. It is possible that more recent data may demonstrate improvements in implementation of these recommendations. In addition, we did not include patients with severe hypoglycemia treated in the community; thus, our study includes a small subset of patients with type 2 diabetes exposed to severe hypoglycemia. Finally, we measured prescription fills and HbA_{1c} levels, both of which may be affected by patient adherence to clinician recommendations or cost of medications and devices.

There are many barriers to timely treatment deintensification. Clinicians may be constrained by performance metrics and population health management efforts that reward lowering HbA_{1c} levels without balancing minimization of hypoglycemic events. These barriers may be addressed by development and integration of quality metrics focused on hypoglycemia. The overall lack of change in management highlighted by this study may also be due to inadequate integration of care, insufficient awareness of guideline recommendations, or lack of specificity in clinical recommendations on how to effectively prevent recurrent hypoglycemia-related utilization.

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