Evaluation of a Pharmacist-Managed Antidiabetic Deprescribing Program in an Integrated Health Care System

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ABSTRACT

BACKGROUND: In the elderly, use of medications may increase the propensity for adverse drug events due to alterations in pharmacokinetic and pharmacodynamic profiles from normal aging processes. Deprescribing is the planned and supervised process of dose reduction or discontinuation of medications that may lead to harm or are no longer beneficial. While there are studies detailing strategies to deprescribe medications such as benzodiazepines and antipsychotics in nursing homes or for patients with dementia, there is a lack of guidance to safely deprescribe chronic medications, such as antidiabetics, for older patients in the community setting.

OBJECTIVE: To evaluate the risk of hypoglycemia and other outcomes of pharmacist-managed deprescribing on selected antidiabetic medications under the guidance of a standardized program compared with usual care within an integrated health care system.

METHODS: This was a retrospective propensity score-matched cohort study. The pharmacist-managed deprescribing group included patients who were enrolled in the deprescribing program between July 1, 2016, and June 30, 2017. The usual care group included eligible patients who did not receive the deprescribing intervention and were matched to the deprescribing group using propensity score matching (PSM). Baseline demographics and clinical variables were used for matching. Patients were followed for 6 months or the end of membership or death, whichever occurred first. Primary outcome was the risk of hypoglycemia. Secondary outcomes included risk of hyperglycemia, proportion of patients at goal (A1c), change in A1c, change in monthly antidiabetic drug cost, and all-cause mortality. Outcomes were analyzed using descriptive statistics and multivariate regression or Cox proportional hazard models when appropriate.

RESULTS: After PSM, 685 patients in the deprescribing group and 2,055 patients in the usual care group were similar in age, gender, weight, and comorbidity burden (mean [SD] age 82.4 [5.4] years, 48% female, mean [SD] weight 81.7 [19.2] kg, mean [SD] Charlson Comorbidity Index score 3.2 [1.6]). Compared with the usual care group, the deprescribing group had a lower risk of hypoglycemia (1.5% vs. 3.1%, $P < 0.02$; adjusted odds ratio 0.42, $P < 0.01$). As for the secondary outcomes, the deprescribing group had a greater change (SD) in A1c (0.3 [0.6] vs. 0.2 [0.7] $P < 0.01$) and lower all-cause mortality (2.3% vs 5.6%, $P < 0.01$; adjusted hazard ratio 0.35, $P < 0.01$). There were no differences observed in the risk of hyperglycemia, proportion of patients at goal A1c $< 7\%$, and change in monthly antidiabetic drug costs between the 2 groups.

CONCLUSIONS: There are currently no studies to our knowledge that evaluate the outcomes of a pharmacist-managed deprescribing program targeting antidiabetic medications. The results of our study showed that deprescribing of selected antidiabetics reduced the risk of hypoglycemia and may have mortality benefit in elderly patients with well-controlled type 2 diabetes, who are taking medications that can cause hypoglycemia. Further and longer studies are needed to validate these benefits.

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What is already known about this subject

- Polypharmacy is increasing in incidence and is associated with worse clinical outcomes, especially in the elderly.
- Hypoglycemia rates due to the use of antihyperglycemics are higher in elderly patients than in younger patients.
- There is limited experience surrounding the process of deprescribing antidiabetic medications in the elderly and limited evidence in terms of clinical outcomes to guide evidence-based decision making.

What this study adds

- Reducing or stopping antihyperglycemics in well-controlled older patients with type 2 diabetes may be effective for reducing hypoglycemia.
- There were no observed differences in the rate of hyperglycemia or proportion of patients at goal hemoglobin A1c among the elderly who had their antidiabetic medications deprescribed.

The U.S. Census Bureau predicted a near-doubling of the population aged 65 years and over during the next few decades.¹ As the human body ages, it develops chronic medical conditions, often requiring medications to control symptoms and improve clinical outcomes. The incidence of polypharmacy, commonly defined as taking 5 or more medications, was estimated to be 36% in the elderly in 2011.² With certain drugs or combinations of drugs, the risk for adverse drug events and use of acute care is increased in the elderly, especially under normal aging processes that alter pharmacokinetic and pharmacodynamic responses. Specifically, the risk of being hospitalized because of a drug-related adverse event has been shown to increase up to 4-fold in elderly with polypharmacy than those without.³⁻⁷ Furthermore, there is a lack of geriatric representation in clinical trials, leaving gaps in clinical evidence for benefit and harm from medications in this population.⁸

Multiple organizations have described the risks of medication overuse in the elderly. The American Geriatrics Society and the European Union maintain lists of medications to avoid in this population.^{9,10} In addition, “The Choosing Wisely Campaign” and the “Screening Tool of Older People’s

Prescriptions (STOPP)” criteria were developed,^{11,12} and the World Health Organization recently launched the third Global Patient Safety Challenge, “Medication Without Harm,”¹³ highlighting the need to reduce unnecessary polypharmacy. Many recent publications suggest the feasibility and potential benefits of deprescribing.¹⁴⁻¹⁸ Deprescribing is defined as the planned and supervised process of dose reduction or stopping of medications that may be causing harm or are no longer beneficial.¹⁹ While there are studies detailing the deprescribing of medications such as benzodiazepines and antipsychotics, especially in nursing homes or in patients with dementia,²⁰ there has been a paucity of evidence and guidance to systematically identify and deprescribe for community-dwelling older patients taking chronic medication classes.²¹

Current guidelines for type 2 diabetes discuss care for elderly patients, for whom the risk of hypoglycemia-related emergency department (ED) visits is doubled relative to younger patients, with consequences of hypoglycemia including falls, cognitive decline, and/or death.^{22,23} Lipska et al. (2014) reported that hospital visits for hypoglycemia have exceeded those for hyperglycemia in the Medicare population.²⁴

The same antidiabetic medications used to provide glucose control in younger patients can become dangerous as patients age due to physiological changes. Although their diabetes may be under control, older patients may find that continuing their diabetes medications could result in hypoglycemia and/or cause burden in daily life.²⁵ For example, the discontinuation of insulin in an elderly patient would reduce the daily injection burden many older adults find difficult due to natural worsening of dexterity and vision.²³ Hence, there may be potential benefits in deprescribing antidiabetic medications in certain elderly patients. During the time of this study, a team in Canada published guidelines for antidiabetic deprescribing in the elderly, furthering the drive to study deprescribing in this population.²⁶

In a partnership with the clinical pharmacy program of Kaiser Permanente Northern California (KPNC) and The Permanente Medical Group (TPMG), a deprescribing program was envisioned to be beneficial to Kaiser Permanente’s senior members. This collaboration led to the development of algorithms that target older members who may be at risk for side effects of antidiabetic medications. This study evaluated the risk of hypoglycemia and other outcomes of a pharmacist-managed deprescribing program that was developed and implemented at KPNC.

Methods

Setting

This retrospective propensity score-matched cohort study was conducted within KPNC, a large not-for-profit integrated health care system serving over 4 million members. KPNC

has used an electronic medical record (EMR) system since 2006. In addition to storing demographics, membership, and claims data, the EMR system collects time-stamped clinical data generated from inpatient and outpatient visits, telephone encounters, laboratory test results, and drug dispenses. One of the keys to population health management in KPNC is the integration of clinical pharmacists in the primary care setting alongside physicians. Under physician-approved collaborative drug therapy management (CDTM) protocols, clinical pharmacists have prescriptive authority to initiate, adjust, or stop medications directly with patients, to the extent allowed by state law. Clinical pharmacists with KPNC are typically residency-trained and/or hold board certification in a relevant area of practice (e.g., pharmacotherapy, ambulatory care pharmacy, or geriatric pharmacy). The KPNC Institutional Review Board reviewed and approved this study. Informed consent was waived because of the retrospective nature of the study.

Deprescribing Program

The deprescribing program was initiated in 2016 through a collaboration between TPMG and KPNC Clinical Pharmacy. A CDTM protocol on deprescribing was created under the partnership and was approved by the TPMG Regional Pharmacy and Therapeutics Committee. The workflow of the program began with identifying potentially eligible patients based on an internally created algorithm, which began to screen EMR records quarterly. Primary care physicians of eligible patients were contacted by centrally located pharmacists for permission to evaluate them as possible candidates to have their antidiabetic medications deprescribed if appropriate. After receiving physician approval, clinical pharmacists reviewed each patient’s chart and determined if each patient was a candidate to have selected antidiabetic medications deprescribed based on the pharmacist’s clinical judgement. Preference of deprescribing target was given to medications associated with a higher risk of hypoglycemia, such as insulin or sulfonylureas.

Clinical pharmacists then contacted the patients via telephone to discuss deprescribing the target medications as guided by the patient’s drug regimen, preference, and lifestyle. A shared decision on the best actions to take (i.e., dose reduction and/or discontinuation) was made together by the patients, their caregivers if present, and the clinical pharmacists. Routine follow-up via telephone with the deprescribing pharmacist was typically scheduled within the next 2-4 weeks. In addition, the clinical pharmacist was accessible via secure online message through the health plan’s member website or via telephone for questions between visits. Home glucose readings were evaluated at follow-up, and if needed, further deprescribing was considered until the process was deemed completed by the clinical pharmacist. There was also a feedback loop via the EMR using progress notes and electronic messages between the

clinical pharmacist and each patient's primary care physician on the progression of deprescribing medications. The program was staffed by the equivalent of 2 full-time clinical pharmacists across 8 individual pharmacists.

Study Design and Populations

This was a retrospective propensity score-matched cohort study of elderly patients with type 2 diabetes who qualified for the deprescribing program. Patients were included in the study if they were aged 75 years or older at study index date (defined later), picked up a prescription of an antidiabetic medication other than metformin within the 6 months before the patient list creation date, and met at least one of the following criteria within the 2 years to patient list creation date: (a) the 2 most recent consecutive measurements of hemoglobin A1c (A1c) were both $\leq 6.5\%$ or (b) the 2 most recent consecutive measurements of A1c were $\leq 7.0\%$ and had either an ED encounter or hospitalization for hypoglycemia (which was defined as having a principal diagnosis of either *International Classification of Diseases, Ninth Revision, Clinical Modification* [ICD-9-CM] codes 249.3, 249.8, 250.8, 251.0, 251.1, and 251.2 or *International Classification of Diseases, Tenth Revision, Clinical Modification* [ICD-10-CM] codes E08.64, E09.64, E11.64, E13.64, E16.0, E16.1, and E16.2). Patients were excluded if they were not members or had no recorded weight during the 6 months before the study index date. Patients taking metformin as monotherapy for diabetes were also not eligible.

The pharmacist-managed deprescribing group included patients who were contacted by a pharmacist for enrollment in the antidiabetic deprescribing program between July 2016 and June 2017. The index date for the deprescribing group was defined as the initial pharmacist contact date. There were more eligible patients than the deprescribed program's capacity during the study period.

The usual care group included patients who were eligible for the program but did not have their medical records reviewed or were not contacted or did not have any intervention by clinical pharmacists from the deprescribing program as of December 2017, which ruled out the possibility of any usual care patient receiving an intervention from this deprescribing program during the study period. The index date for the usual care group was defined as the date of the first physician office visit after a patient qualified for the program. Since there were more patients in the usual care group, propensity score matching (PSM) was used to minimize selection bias by balancing the differences in baseline characteristics and demographics between the 2 groups. Usual care group patients were matched to the deprescribing group using PSM at a 3:1 ratio. The propensity score was estimated using a logistic regression model to calculate the likelihood that a patient would receive a clinical pharmacist intervention, using various pretreatment characteristics.

The pretreatment characteristics used in PSM included age; gender; race (white vs. nonwhite); body weight; Charlson Comorbidity Index (CCI) score²⁷; most recent A1c before the index date; antidiabetic drug class (i.e., insulin, sulfonylurea, metformin, thiazolidinedione, and/or dipeptidyl peptidase-4 inhibitor) within 6 months before the index date with specific drug class presented as a dichotomous variable; and presence of hypoglycemic events within 6 months before the index date as a dichotomous variable.

Hypoglycemia was defined as a composite of a laboratory measurement of glucose < 54 mg/dL or an ED visit or hospitalization with a primary diagnosis of hypoglycemia (ICD-9-CM codes 249.3, 249.8, 250.8, 251.0, 251.1, and 251.2 or ICD-10-CM codes E08.64, E09.64, E11.64, E13.64, E16.0, E16.1, and E16.2).

Endpoints

All patients were followed up to 6 months or end of membership or death, whichever occurred first. The primary outcome was the proportion of patients who experienced hypoglycemia during the follow-up period. Hypoglycemia was defined as a composite of a laboratory measurement of glucose < 54 mg/dL or an ED visit or hospitalization with a primary diagnosis of hypoglycemia (ICD-9-CM codes 249.3, 249.8, 250.8, 251.0, 251.1, and 251.2 or ICD-10-CM codes E08.64, E09.64, E11.64, E13.64, E16.0, E16.1, and E16.2).

Secondary outcomes included all-cause mortality, proportion of patients who experienced hyperglycemia, proportion of patients at goal A1c, change in A1c, and change in average monthly antidiabetic drug cost per member per month (PMPM) during the follow-up period. Death was ascertained through health plan membership data, which recorded the date of death for members who died at any KPNC facility or ceased membership as a result of death.

Hyperglycemia was defined as a composite of a laboratory blood glucose measurement over 200 mg/dL or an ED visit or hospitalization with a primary diagnosis of hyperglycemia (ICD-9-CM codes 250.1, 250.2, and 790.2 or ICD-10-CM codes E08.65, E09.65, E11.65, and E13.65).

Goal A1c was defined as less than 7%, while the change in A1c was defined as the difference between the baseline A1c and the follow-up A1c. The baseline A1c was defined as the closest A1c measured before the index date, while the follow-up A1c was measured within 2-6 months after the index date to allow enough time to detect changes from the baseline. If a patient had multiple A1c measurements during the follow-up period, the latest reading during the follow-up period was used. Patients without follow-up A1c were not included in outcomes using follow-up A1c values. The change in average monthly antidiabetic drug cost PMPM was calculated by subtracting the mean monthly antidiabetic drug cost within the previous 6 months from the mean drug cost during the follow-up period.

FIGURE 1 Patient Selection Flowchart

^aPatients may be excluded due to multiple exclusion criteria.

Statistical Analysis

Approximately 384 patients in the deprescribing group and 1,152 patients in the usual care group were required to achieve 80% power on the significance level of 0.05 to detect an absolute 2% decrease in the proportion of patients who experienced hypoglycemia, assuming the rate of hypoglycemia was 3%.²⁵ Descriptive analyses were performed to compare all the baseline demographics and characteristics before and after PSM for both groups. Pearson chi-square tests were used to compare categorical variables, and Student's t-tests were used to compare continuous variables. Multivariate logistic regressions were conducted to estimate the likelihood of hypoglycemia between the 2 groups.

Other covariables included in the logistic regression were age, gender, race, CCI score, baseline A1c, and other baseline variables measured within 6 months before the index date, including the use of insulin or sulfonylurea, total number of prescriptions, and the presence of hypoglycemia.

The log rank test was used to compare mortality risk over time between the pharmacist-managed group and the usual care group. A Kaplan-Meier curve was created to graphically display the mortality probability of the 2 groups over time. A Cox proportional hazards model was used to analyze the adjusted risk of mortality between the deprescribing group and the usual care group. Additional covariables included in the Cox proportional hazards model were age, gender, race, CCI score, and total number of prescriptions within 6 months before the index date. Results were considered statistically

significant at P values <0.05 . The SAS statistical package, version 9.4 was used for all analyses (SAS Institute, Cary, NC).

Results

Patients

During the study period, 7,673 patients were eligible for the deprescribing program. After inclusion and exclusion criteria were applied, 685 patients received a clinical pharmacist intervention, while 6,520 patients did not receive the intervention (Figure 1). Several baseline variables, including age, race, body weight, and CCI score, were significantly different between the 2 groups before matching (Table 1). After performing PSM, 2,055 patients from the 6,520 patients who did not receive intervention were selected to become the usual care group at a ratio of 3:1 to the deprescribing group. After matching, there were no statistical differences between the 2 groups in age, gender, race, baseline body weight, CCI score, baseline A1c, and the baseline antidiabetics drug classes used (Table 1).

The final cohort, combining the deprescribing and usual care groups, were 48% female, had a mean age (standard deviation [SD]) of 82.4 (5.4) years, a mean (SD) CCI score of 3.2 (1.6), and mean (SD) body weight was 81.7 (19.2) kg at baseline. The majority (93.8%) of the cohort was followed for the 6-month follow-up period, while 1.4% and 4.8% lost membership or deceased during the study period, respectively.

Effectiveness Outcomes

The effectiveness outcomes were the rates of hypoglycemia and mortality. The proportion of patients who experienced hypoglycemia was significantly lower in the deprescribing

TABLE 1 Baseline Demographics Before and After Propensity Score Matching

	Deprescribing n = 685	Before Propensity Score Matching		After Propensity Score Matching	
		Usual Care ^a n = 6,520	P Value ^b	Usual Care ^a n = 2,055	P Value ^b
Age, years ± SD ^c	82.5 ± 5.1	81.7 ± 5.2	<0.01	82.3 ± 5.4	0.56
Female, n (%) ^d	331 (48)	3,003 (46)	0.26	973 (47)	0.66
Race, n (%) ^d			<0.01		0.06
White	415 (61)	2,150 (33)		1,162 (57)	
Other/unknown	270 (39)	4,370 (67)		893 (43)	
Weight (kg), mean ± SD ^c	81.3 ± 17.9	83.2 ± 19.5	0.02	81.5 ± 19.4	0.80
CCI score, n (%) ^d			<0.01		0.06
≤ 2	233 (34)	1,729 (27)		734 (36)	
3-4	336 (49)	3,059 (47)		909 (44)	
5+	116 (17)	1,732 (27)		412 (20)	
Mean ± SD, ^c	3.1 ± 1.5	3.6 ± 1.7	<0.01	3.2 ± 1.7	0.29
A1c, n (%) ^d			<0.01		0.80
≤ 5.6	103 (15)	559 (10)		290 (14)	
5.7-6.4	538 (79)	4,534 (70)		1,625 (79)	
≥ 6.5	44 (6)	1,317 (20)		140 (7)	
DM drug class, n (%) ^d					
Insulin	117 (17)	2,052 (32)	<0.01	354 (17)	0.93
Sulfonylurea	568 (83)	4,795 (74)	<0.01	1,709 (83)	0.88
Metformin	213 (31)	2,088 (32)	0.62	651 (32)	0.78
TZD	40 (6)	302 (5)	0.16	115 (6)	0.81
DPP-4 inhibitor	3 (0.4)	63 (1)	0.17	8 (0.4)	0.86

^aMatched using propensity score created by pretreatment characteristics: age, gender, race, body weight, CCI score, baseline A1c, baseline use of antidiabetic drug classes, and presence of hypoglycemic events at baseline.

^bP values reflect comparison with deprescribing group.

^cT-test.

^dChi-square test.

A1c = hemoglobin A1c; CCI = Charlson Comorbidity Index; DM = diabetes mellitus; DPP = dipeptidyl peptidase; SD = standard deviation; TZD = thiazolidinedione.

group than in the usual care group (1.5% vs. 3.1%, respectively, $P < 0.02$; Table 2). The adjusted odds ratio (OR) for the deprescribing group of experiencing hypoglycemia was 0.42 (95% confidence interval [CI] = 0.20-0.81, $P < 0.01$) compared with the usual care group (Table 3). This translated into a 2.4 times lower risk for hypoglycemia in the deprescribing group, after adjusting for various potential confounders. Other variables associated with hypoglycemia included having a history of hypoglycemia within 6 months before the index date (OR = 4.00, 95% CI = 1.11-11.32) and using insulin therapy at baseline (OR = 2.39, 95% CI = 1.08-4.93).

The observed mortality rate was significantly lower in the deprescribing group versus the usual care group (2.3% vs 5.6%, $P < 0.01$). A Kaplan-Meier curve (Figure 2) shows the differences in the rate of mortality during the time period ($P < 0.01$). When mortality was adjusted using a Cox proportional hazards model, the adjusted hazard ratio for the deprescribing group was 0.35 (95% CI = 0.20-0.59, $P < 0.01$) when compared with the usual care group, which suggested that the hazard rate for mortality was over 2.5 times lower in the deprescribing group. There may have been unobserved risk in the usual care group that was not present in the study group.

Safety Endpoints

There was no significant difference in the proportion of patients who experienced hyperglycemia between the deprescribing group and usual care group (0.4% vs. 0.1%, $P = 0.52$). Among the 92% (630 of 685) and 83% (1,698 of 2,055) of patients with A1c measured between 2 and 6 months after the index date, the change (SD) in A1c was significantly greater in the deprescribing group than the usual care (0.3 [0.6] vs. 0.2 [0.7], $P < 0.01$). However, the proportion of patients with A1c at 7% or above was not different between the 2 groups (deprescribing 11% vs. usual care 11%, $P = 0.96$).

Economic Outcome

There was no difference in the change (SD) in monthly antidiabetic drug costs between the 2 groups (\$5.2 [35.2] deprescribing group vs. \$5.2 [25.3] usual care group, $P = 0.99$).

Discussion

As far as we know, this is the first study to investigate outcomes of an ambulatory care-based, pharmacy-managed deprescribing program for antidiabetic drugs in elderly patients in the

TABLE 2 Unadjusted Outcomes

	Deprescribing n = 685	Usual Care n = 2,055	P Value
Effectiveness			
Hypoglycemia, ^a n (%)			
Baseline ^b	8 (1.2)	23 (1.1)	0.92
During follow-up ^b	10 (1.5)	64 (3.1)	<0.02
Death, n (%)	16 (2.3)	115 (5.6)	<0.01
Safety			
Hyperglycemia, ^c n (%)			
Baseline ^b	4 (0.6)	17 (0.8)	0.53
During follow-up ^b	3 (0.4)	21 (0.1)	0.52
	n = 630	n = 1,678	
A1c < 7%, n (%)	559 (89)	1,490 (89)	0.96
Change in A1c (%), mean ± SD ^d	0.3 ± 0.6	0.2 ± 0.7	<0.01
Economics			
Change in antidiabetic drug costs, PMPM (\$), mean ± SD	-5.2 ± 35.2	-5.2 ± 25.3	0.99

^aHypoglycemia: Defined as an emergency department visit or inpatient hospitalization with a primary diagnosis of hypoglycemia or a glucose value of <54 mg/dL.

^bChi-square test.

^cHyperglycemia: Defined as an emergency department visit or inpatient hospitalization with a primary diagnosis of hyperglycemia or >200 mg/dL.

^dT-test.

A1c = hemoglobin A1c; PMPM = per member per month; SD = standard deviation.

community setting. We found that a pharmacist-managed deprescribing program reduced the risk of hypoglycemia in elderly patients with well-controlled type 2 diabetes who were taking antidiabetic medications. In addition, we observed a 2-fold decrease in all-cause mortality in the pharmacist-managed deprescribing patients, when compared with usual care. We do not have a good explanation for this observation but believe that there may be unobservable factors that relate to all-cause mortality. No differences in the risk of hyperglycemia were observed; however, the sample size of the study was not large enough to detect a difference. Furthermore, although a statistically significant increase in A1c was observed, the absolute difference was 0.1% between the study group and usual care group and was not considered to be of a clinical meaningful significance. The U.S. Food and Drug Administration and a survey of clinicians consider a change of 0.4% and 0.5%, respectively, to be a clinically significant change.^{28,29} Furthermore, there were no differences in the proportion of patients at goal A1c.

We did not find a decrease in monthly antidiabetic drug costs in the deprescribing group, likely because more than half of the patients (n = 366, 53%) reduced the dose of their antidiabetic medications rather than discontinuing the drug. Therefore, the medication costs were not eliminated for those patients. Although we did not observe a direct medication cost benefit for the study group, the cost benefit from a lower rate of hypoglycemia, a composite endpoint of ED visits or

TABLE 3 Multivariate Logistic Regression for the Likelihood of Experiencing Hypoglycemia

C-statistic = 0.729	Odds Ratio (95% CI)	P Value ^a
Pharmacist-managed care vs. usual care	0.42 (0.20-0.81)	<0.01
Female	0.73 (0.45-1.18)	0.20
Age, years		
≤78	Reference	
79-81	1.10 (0.53-2.23)	0.70
82-85	1.57 (0.82-3.02)	0.19
≥86	1.21 (0.62-2.36)	0.97
Baseline A1c (reference ≥ 6.5)		
≤5.6	0.86 (0.32-2.42)	0.86
5.7-6.4	0.84 (0.39-2.09)	0.74
≥6.5	Reference	
Hypoglycemia at baseline	4.00 (1.11-11.32)	0.02
History of insulin therapy	2.39 (1.08-4.93)	0.02
History of sulfonylurea therapy	1.48 (0.65-3.34)	0.34

Note: Multivariate logistic regression also controlled for CCI score, race, and total prescription count at baseline.

^aBold indicates significance.

A1c = hemoglobin A1c; CCI = Charlson Comorbidity Index; CI = confidence interval.

hospitalization with a primary diagnosis of hypoglycemia, or laboratory measurement of glucose <54 mg/dL can be realized through decreased acute care use and may be extrapolated in future cost benefit analyses.

There are several strengths of this study. The first was the ability to use propensity scores to match a control group, which had similar demographics and characteristics as the deprescribing group. The study design allowed us to compare many outcomes, such as mortality, that a pre-post design would not have been able to compare. In addition, this study was conducted in an integrated system, which provided health care data on patients as they were captured in the EMR. The interventions provided through the pharmacist-managed deprescribing program were consistent, since the program is a well-structured process that was developed and has been maintained through a strong partnership and mutual trust between physicians and pharmacists.

Limitations

Limitations to this study include those inherently associated with a retrospective study design, such as selection bias. There are unobservable reasons that patients in the usual care group were different from the deprescribing group. For example, clinical pharmacists were not able to reach some patients by phone or the patients may have refused to have their medications deprescribed and so were not enrolled in the program. Since this study was only able to use observable demographics and clinical markers to select a control group using the

FIGURE 2 Kaplan-Meier Curve: Mortality Probability over Time

propensity score method, we were not able to account for these selection biases. To minimize bias, we did not include any patients whom pharmacists had attempted to contact or who had refused to have their medications deprescribed as potential controls for this study.

We were also not able to use death certificates to verify mortality data because that data have a 2-year lag period. The current mortality data were generated within our membership data, which capture deaths occurring within our integrated health system or reported by the payer. However, because this potential data lag affected all patients equally, there was no reason to believe that there was bias favoring either the deprescribing or usual care group.

We were also limited by the small sample size and a short follow-up period. However, the study cohort was large enough to meet the predetermined sample size for measuring the primary outcome. Nevertheless, this study has provided important insight on the effects of deprescribing, and the investigators hope to share these results and best practices rapidly rather than wait for a larger sample or a longer follow-up period.

Finally, the results may not be generalizable because Kaiser Permanente has various programs to assist with diabetes management and connected technologies to facilitate provider-to-provider and provider-to-patient communication, whereas other health care systems may not have the same infrastructure or resources.

Conclusions

To reduce polypharmacy and improve quality of life in well-controlled older patients with type 2 diabetes, a deprescribing

program for antidiabetic medication use in the elderly was developed and implemented. The program has demonstrated positive results in lowering the rates of hypoglycemia, without compromising the proportion of patients at goal A1c or increasing the incidence of hyperglycemia. Future work is needed to evaluate a longer follow-up period, explore other outcomes, and validate the results in different settings.

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