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A Real-World Observational Study of Time to Treatment Intensification Among Elderly Patients with Inadequately Controlled Type 2 Diabetes Mellitus

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Abstract

BACKGROUND—Among elderly patients, the management of type 2 diabetes mellitus (T2DM) is complicated by population heterogeneity and elderly-specific complexities. Few studies have been done to understand treatment intensification among elderly patients failing multiple oral antidiabetic drugs (OADs).

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DISCLOSURES

Sanofi U.S. provided research funding support, proposed and codeveloped the concept, and codeveloped the analysis plan. Sanofi was also involved in interpreting the results of the analyses, reviewing the manuscript, and providing comments on the manuscript versions. Sanofi approved the manuscript to be submitted for publication.

Ajmera, Raval, and Bhattacharya were PhD students at West Virginia University at the time this manuscript was written. Raval and Sambamoorthi have no disclosures. Zhou and Wei are employees of Sanofi U.S. Pan is an employee of Pro Unlimited, under contract with Sanofi U.S. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the organizations that supported the study.

Study design was created by Ajmera, Wei, and Sambamoorthi, assisted by Raval, Bhattacharya, and Zhou. Zhou, Pan, and Sambamoorthi took the lead in data collection, with assistance from Ajmera, Wei, and Bhattacharya. Data interpretation was performed by Ajmera, Raval, Bhattacharya, and Sambamoorthi. The manuscript was written primarily by Ajmera, along with Raval and assisted by Bhattacharya and Sambamoorthi, and revised by Ajmera, Raval, and Sambamoorthi, with assistance from Zhou, Wei, and Bhattacharya.

OBJECTIVE—To examine the association between time to treatment intensification of T2DM and elderly-specific patient complexities.

METHODS—In this observational, retrospective cohort study, elderly (aged ≥ 65 years) Medicare beneficiaries (n = 16,653) with inadequately controlled T2DM (hemoglobin A1c ≥ 8.0% despite 2 OADs) were included. Based on the consensus statement for diabetes care in elderly patients published by the American Diabetes Association and the American Geriatric Society, elderly-specific patient complexities were defined as the presence or absence of 5 geriatric syndromes: cognitive impairment; depression; falls and fall risk; polypharmacy; and urinary incontinence.

RESULTS—Overall, 48.7% of patients received intensified treatment during follow-up, with median time to intensification 18.5 months (95% CI = 17.7–19.3). Median time to treatment intensification was shorter for elderly patients with T2DM with polypharmacy (16.5 months) and falls and fall risk (12.7 months) versus those without polypharmacy (20.4 months) and no fall risk (18.6 months). Elderly patients with urinary incontinence had a longer median time to treatment intensification (18.6 months) versus those without urinary incontinence (14.6 months). The median time to treatment intensification did not significantly differ by the elderly-specific patient complexities that included cognitive impairment and depression. However, after adjusting for demographic, insurance, clinical characteristics, and health care utilization, we found that only polypharmacy was associated with time to treatment intensification (adjusted hazard ratio, 1.10; 95% CI = 1.04–1.15; *P* = 0.001).

CONCLUSIONS—Less than half of elderly patients with inadequately controlled T2DM received treatment intensification. Elderly-specific patient complexities were not associated with time to treatment intensification, emphasizing a positive effect of the integrated health care delivery model. Emerging health care delivery models that target integrated care may be crucial in providing appropriate treatment for elderly T2DM patients with complex conditions.

Uncontrolled diabetes, defined as high levels of hemoglobin A1c (A1c; e.g., > 7.0%), among patients with type 2 diabetes mellitus (T2DM) is often treated by intensifying current treatment, either by adding oral antidiabetes drugs (OADs) or injectable drugs (e.g., insulin), or by increasing the dose(s) of the current drug(s).¹ Findings from randomized controlled trials have shown the benefits of treatment intensification among patients with T2DM with inadequately controlled diabetes with regard to reduction in A1c values.^{2,3} An observational study found that patients with T2DM with inadequately controlled diabetes who received treatment intensification were 67% less likely to have a 30-day hospital readmission or emergency department (ED) visit, as compared with those patients with T2DM without treatment intensification.⁴

However, studies in different settings, such as U.S. Veterans Affairs institutions, integrated managed care practices, and general practices, have reported that among patients with T2DM with inadequately controlled diabetes (A1c ≥ 8.0%), treatment intensification rates can be as low as 20.8%⁵ and as high as 64.0%.⁶ It must be noted that both these studies included elderly (aged ≥ 65 years) and nonelderly patients with T2DM. In addition, rates of treatment intensification have been found to be significantly lower among elderly individuals with T2DM. For example, at a U.S. Veterans Affairs institution, elderly patients with T2DM in the age groups 65–74 years and ≥ 75 years had lower treatment

intensification rates compared with younger patients aged < 65 years with T2DM (18.6% and 17.3% vs. 23.3%, respectively).⁵

Although joint guidelines from the American Diabetes Association (ADA) and the European Association for the Study of Diabetes suggest that treatment intensification should be “at as rapid a pace as titration of medications allows,”⁷ time to treatment intensification and factors associated with it among elderly patients have not been well researched. In a study, non-specific to the elderly, that used data from 2002 on all members of the Kaiser Permanente Medical Care Program of Northern California, 57% of members who had inadequately controlled T2DM (A1c ≥ 8.0%) had their pharmacological therapy modified within 3 months.⁸ An observational, retrospective cohort study using a General Electric Centricity electronic medical record database found that the median time to treatment intensification among individuals with T2DM who failed metformin therapy was 14 months.

Although not specifically for elderly patients, the findings from this study indicate that age may be inversely associated with time to treatment intensification (adjusted hazard ratio [aHR], 0.995; 95% confidence interval [CI] = 0.992–0.997; $P < 0.001$).⁶ Other investigators studied data from a multispecialty group practice in southeast Michigan. They found that in patients with T2DM who, despite receiving monotherapy with OADs, had sustained hyperglycemia (defined as 2 A1c values of > 8.0% and no recent treatment intensification), the mean time to treatment intensification was 9.7 months.⁹ The mean age ($\pm$ standard deviation [SD]) of the patients in this study was 58 (± 12) years.⁹

Treatment intensification, which has a significant role in the attainment of glycemic control, can have a positive impact on A1c levels among elderly patients with T2DM; the prevalence of T2DM can be as high as 27% in the elderly population.¹⁰ There is also a need for personalized treatment intensification among elderly patients with T2DM because of the complexities associated with the aging process. Guidelines published by the American Geriatrics Society (AGS) emphasize the fact that frailties and complexities of older patients with diabetes need to be considered when managing diabetes among the elderly.¹¹ In this context, the AGS has highlighted 6 syndromes in particular that require consideration: cognitive impairment; depression; falls and fall risk; pain; polypharmacy; and urinary incontinence. None of the studies mentioned above has studied the association between time to treatment intensification and elderly-specific patient complexities.

The primary objective of this study, therefore, was to examine the association between time to treatment intensification and elderly-specific patient complexities as novel risk factors for treatment intensification after controlling for clinical, demographic, and insurance characteristics; and health care utilization among elderly individuals who have inadequate glycemic control (A1c ≥ 8.0%) despite treatment with 2 OADs.

Methods

Study Design

An observational, retrospective cohort study design was used to estimate the median time to treatment intensification and factors associated with time to treatment intensification in a

cohort of elderly patients with T2DM who, despite treatment with 2 OADs, had an A1c level $\geq 8.0\%$. The index date was defined as the first observed date with an A1c level $\geq 8.0\%$. The baseline period was defined as 6 months before the index date, and the follow-up period was defined as the period from the index date to the date of treatment intensification or the end of the study observation period (February 28, 2012), or the disenrollment date of the Medicare beneficiary.

Data Source

Data from elderly patients with T2DM who were enrolled in the Humana Medicare Advantage Prescription Drugs (MAPD) plan database between January 1, 2007, and February 28, 2012, were used. This database includes claims data from more than 12 million current and previous Humana members and contains information on nearly 1.9 million MAPD plan members.

For these members, enrollment, and medical, pharmacy, and laboratory results claims files were made available to researchers. The enrollment files contain information on year of birth, race, sex, and monthly enrollment status of Medicare beneficiaries. The medical claims files contained information on hospitalization, cost, and diagnosis (based on the *International Classification of Diseases, Ninth Revision, Clinical Modification* [ICD-9-CM] diagnosis codes, and the American Medical Association Current Procedural Terminology codes). Pharmacy claims files included information on prescription fill date, days of supply, and the national drug codes for each dispensed medication. Laboratory results were available only for a third of the total enrolled population. The key fields in the laboratory claims were laboratory test codes and laboratory test results from which A1c values could be captured.

Study Population

The study population comprised elderly patients with T2DM aged ≥ 65 years at index date. T2DM was identified according to ICD-9-CM diagnosis codes 250.x0 (Diabetes mellitus type 2) and 250.x2 (Diabetes mellitus type 2, uncontrolled). Elderly patients with at least 1 inpatient visit or ≥ 2 outpatient visits with a primary or secondary diagnosis of T2DM were considered to have diagnosed T2DM. Several other inclusion criteria were applied in order to obtain the cohort for analysis: continuous enrollment for 6 months during the baseline period; receipt of any 2 OADs (metformin, sulfonylureas, thiazolidinediones, dipeptidyl peptidase-4 inhibitors, alpha-glucosidase inhibitors, meglitinides) during the baseline period; and nonreceipt of pramlintide, a glucagon-like peptide-1 receptor agonist, or any insulin during the baseline period.

Dependent Variable: Time to Treatment Intensification

Among patients with T2DM in whom treatment was intensified during the observation period, time to treatment intensification was calculated as the number of months between the index date and the first observed date with intensification (defined as either initiation of insulin or addition of a third OAD). T2DM patients who did not receive treatment intensification during the observation period were considered “censored” and separated from the patient cohort with treatment intensification. Time to treatment intensification among

those patients with T2DM with no treatment intensification during the follow-up period was calculated as the number of months between the index date and the study observation end date.

Independent Variables

All independent variables were measured during the baseline period.

Demographic and Insurance Characteristics—Demographic variables included age (65–74 and ≥ 75 years); sex; race (white, African American, Hispanic, and other); and U.S. region (Midwest, South, and Northeast/Northwest/other). Insurance type (health maintenance organization [HMO], preferred provider organization, fee-for-service, and other) and MAPD coverage gap (popularly known as the “donut hole”) were assessed. Patients were defined to be in the donut hole if they had the coverage gap during the baseline period, whereas those without the coverage gap were categorized as being present in the pre- or post-donut hole phase.

Health Care Utilization—Health care utilization was identified as any inpatient visits, any ED visits, or number of outpatient office visits grouped as 0, 1–2, or ≥ 3.

Clinical Characteristics—Diabetes severity was assessed as a clinical characteristic using the Diabetes Complications Severity Index (DCSI),¹² which used automated diagnostic data (i.e., ICD-9-CM codes) without laboratory data, using the modified algorithm by Chang et al. (2012).¹³ DCSI scores were grouped into 4 categories based on quartiles. The presence of hypoglycemia was measured using the Ginde algorithm¹⁴ and baseline A1c values were categorized as follows: ≥ 8.0% to < 8.5%; ≥ 8.5% to < 9.0%; and ≥ 9.0%. Co-occurring conditions were defined using an algorithm specifically developed for “diabetes care within the context of comorbid conditions” by Piette and Kerr (2006)¹⁵ and were classified based on the following hierarchy: dominant, concordant, and discordant conditions. Because of considerable overlap between concordant conditions and DCSI and other measures of elderly-specific patient complexities, only 1 discordant condition, the presence of chronic obstructive pulmonary disease (COPD), and 1 dominant condition, the presence of cancer, were used to define co-occurring conditions.

Elderly-Specific Patient Complexities—Based on the consensus statement for diabetes care in elderly patients published by the ADA and the AGS, elderly-specific patient complexities were defined as the presence or absence of 5 geriatric syndromes: cognitive impairment; depression screening; falls and fall risk; polypharmacy; and urinary incontinence.¹¹ These elderly-specific patient complexities were identified using the ICD-9-CM diagnosis codes presented in the Appendix. Cognitive impairment was defined as the presence of Alzheimer’s disease, dementia, Huntington’s disease, Parkinson’s disease, schizophrenia, bipolar disorder, or psychotic disorders. As depression screening was unavailable in the dataset, we used the presence of major depressive disorder as a proxy for depression screening. Falls and fall risk were captured using ICD-9-CM E-codes and V-codes.^{16,17} Polypharmacy was measured as the total number of drugs that were 1 SD above the mean number of drugs.¹⁸ Polypharmacy was further classified as ≥ 6 drugs and > 6

drugs for this assessment. Urinary incontinence was also captured using ICD-9-CM diagnosis codes.¹⁹

Sensitivity Analysis

We also conducted sensitivity analyses by including dose escalation as 1 of the forms of treatment intensification among elderly patients with T2DM who remained on 2 OADs. Dose was considered to have increased if the daily dose of either of the 2 active ingredients from the baseline period was increased anytime during follow-up. The active ingredient information from the baseline period was matched with that in the follow-up period, and if the 2 active ingredients remained the same, the daily doses were directly compared to assess dose escalation. However, in the case of different active ingredients but similar therapeutic classes, dose escalation was derived using the comparison with the maximum daily dose. The maximum daily doses of each medication were obtained using Lexi-Drugs files (with AHFS DI Essentials and AHFS DI for hospital and academic clients). The maximum daily dose of the active ingredient during the baseline period was compared with the other active ingredient during the follow-up period, and individuals were considered to have OAD dose escalation if they had received a maximum daily dose in the follow-up period but not during the baseline period.

Statistical Analysis

Survival analysis techniques were used to test unadjusted and adjusted associations between time to treatment intensification and independent variables. Unadjusted differences were analyzed with Kaplan-Meier product limit estimates, and log-rank tests were used to examine statistically significant differences for days to treatment intensification. In our study, time to treatment intensification is a duration variable with each individual having a start date and an end date anywhere along the time line of the study observation period. Kaplan-Meier analysis is a simpler way of examining differences in time to treatment intensification when not all the individuals received intensification at the same time or did not receive treatment intensification within the observation period (i.e., censoring).²⁰

Multivariable Cox-proportional hazards regression was used to analyze the association between the independent variables and days to treatment intensification in the presence of censoring. The following baseline variables were included in this regression: elderly-specific patient complexities (cognitive impairment, depression, falls and fall risk, polypharmacy, and urinary incontinence); clinical characteristics (DCSI, hypoglycemia, A1c levels, discordant condition [COPD], and dominant condition [cancer]); demographic and insurance characteristics (sex, race, age, U.S. region, insurance type, and donut hole status on index date); and health care utilization (any inpatient visits, any ED visits, and the number of outpatient visits). Parameter estimates are expressed as aHRs and 95% CIs associated with the parameter estimates. Variations in treatment intensification rates were examined by varying the follow-up periods: 4, 6, 12, and 24 months.

Results

After applying all exclusion criteria, we used a study population of 16,653 elderly patients with T2DM with inadequately controlled A1c levels ($\geq 8.0\%$) enrolled in the Humana MAPD plan database. Patient attrition is shown in Figure 1. A majority of the study population was male (51.3%), white (69.4%), aged 65–74 years (63.8%), living in the South of the United States (79.4%), and enrolled in HMO insurance plans (70.1%). In terms of diabetes severity, 34.2% of the study population was within the lowest category of DCSI scores and 30.2% was within the highest. A small proportion of patients had inpatient and ED visits (11.7% and 8.9%, respectively) during the baseline period. The average follow-up time in the study was around 22 months (range 0–56.9 months; median 19.6 months).

In the study population, 48.7% of elderly patients with T2DM received treatment intensification during follow-up, with a median time to treatment intensification of 18.5 months. Table 1 shows the subgroup differences in median time to treatment intensification, 95% CIs, and statistical significance based on log-rank tests. Statistically significant differences in median time to treatment intensification were found for the following variables: age, race, U.S. region, insurance type, prescription drug coverage gap on the index date (in the donut hole), inpatient visits, ED visits, number of outpatient visits, A1c, falls and fall risk, polypharmacy, and urinary incontinence.

Median time to treatment intensification was shorter for elderly patients with T2DM with polypharmacy (16.5 months) and falls and fall risk (12.7 months) versus those without polypharmacy (20.4 months) and no fall risk (18.6 months). Elderly patients with urinary incontinence had a longer median time to treatment intensification (18.6 months) versus those without urinary incontinence (14.6 months). The median time to treatment intensification did not significantly differ by the elderly-specific patient complexities of cognitive impairment and depression. Individuals with baseline A1c values $\geq 9.0\%$ had shorter median time to treatment intensification (12.1 months) than those with A1c values of 8.0% to $< 8.5\%$ and 8.5% to $< 9.0\%$ (23.2 months and 16.9 months, respectively).

Treatment intensification rates varied by follow-up months (Table 2). For example, 23.5% of patients received treatment intensification within 4 months; 27.8% within 6 months, 36.9% within 12 months, and 44.7% within 24 months. Among those with treatment intensification, a majority received it through the addition of a third OAD (58.7%; $n = 4,754$) followed by insulin initiation (41.3%; $n = 3,349$). This finding was consistent across all lengths of follow-up. Statistically significant differences in rates of treatment intensification by age were observed for all follow-up months ($P < 0.001$).

Adjusted hazard ratios and 95% CIs from multivariable Cox-proportional hazards regression are presented in Table 3. The only elderly-specific patient complexity to significantly affect time to treatment intensification was polypharmacy. T2DM patients taking > 6 drugs had a higher aHR of treatment intensification compared with those taking ≤ 6 drugs (aHR, 1.10; 95% CI = 1.04–1.15; $P < 0.001$). Other elderly-specific patient complexities were not significantly associated with time to treatment intensification.

Other variables associated with significantly higher aHRs of treatment intensification were 3 outpatient visits (aHR, 1.09; 95% CI = 1.03–1.15; $P = 0.021$), DCSI categories 1–2 (aHR, 1.07; 95% CI = 1.00–1.14; $P = 0.051$) and 4–12 (aHR, 1.09; 95% CI = 1.02–1.17; $P = 0.025$), and patients with baseline A1c values of 8.5% to < 9.0% (aHR, 1.20; 95% CI = 1.12–1.27; $P < 0.001$) and 9.0% (aHR, 1.51; 95% CI = 1.44–1.59; $P < 0.001$).

Variables associated with lower aHRs of treatment intensification were African American race (aHR, 0.83; 95% CI = 0.79–0.89; $P < 0.001$), aged 75 years (aHR, 0.90; 95% CI = 0.86–0.94; $P < 0.001$), residing in the South of the United States (aHR, 0.88; 95% CI = 0.82–0.95; $P < 0.001$), enrollment in an HMO insurance plan (aHR, 0.85; 95% CI = 0.80–0.91; $P < 0.001$), and pre- or post-donut hole status (aHR, 0.75; 95% CI = 0.70–0.81; $P < 0.001$).

Results from sensitivity analysis (including dose escalation) revealed that median time to treatment intensification decreased to 11.1 months (95% CI = 10.6–11.6). Results from multivariable Cox-proportional hazards regression remained the same as our previous analysis without dose escalation.

Discussion

This study analyzed the factors associated with time to treatment intensification among elderly Humana MAPD plan database patients with T2DM who had A1c levels 8.0% despite using 2 OADs at baseline. The study found that 51.3% of elderly patients with T2DM and A1c levels 8.0% were censored without treatment intensification, and 48.7% received treatment intensification over a period of 4.67 years. As previous studies have included both nonelderly and elderly populations,^{5,6} the current study findings cannot be directly compared. However, in a study that provided data on age categories and was based on author calculations, only 18.3% of elderly patients (aged 65 years) with T2DM had received treatment intensification over a period of 14 months.⁶ This finding suggests that the high rates of treatment intensification observed in the current study could be due to the long follow-up period. In the current study, median time to treatment intensification was 18.5 months, but because of the few studies among elderly patients with T2DM, it is not possible to compare the current study findings to existing studies on time to treatment intensification.

A noteworthy finding of the current study is the absence of an association between treatment intensification and elderly-specific patient complexities except for polypharmacy. These findings suggest that in a managed care setting, patient complexities are not associated with time to treatment intensification. It has been suggested that the quality of diabetes care among MAPD plan enrollees with T2DM and comorbid conditions is higher than in those patients without comorbid conditions.²¹ It is highly plausible that MAPD plan enrollees might receive appropriate treatment irrespective of complexities owing to the provision of direct or indirect integrated and coordinated care.²² Future research needs to explore whether such lack of association is due to personalized treatment goals or better management of diabetes through coordinated care among individuals with T2DM and complex chronic conditions.

In the current study, the only elderly-specific patient complexity that was significant was polypharmacy, and these patients had a shorter duration of time to treatment intensification compared with patients without polypharmacy. A previous study has reported that T2DM patients with OAD polypharmacy were more likely to have poorer glycemic control compared with those patients without polypharmacy.²³ Although not specific to elderly patients with T2DM, predictive models in health care suggest that the number of medications a patient takes is predictive of medical complexity²⁴; therefore, it is possible that health care providers may intensify current treatment(s) in order to reduce adverse outcomes in medically complex patients, for example, those with polypharmacy.

Patients aged 75 years had longer median time to intensification compared with those aged 65–74 years. We do not know of any comparable studies assessing time to intensification in elderly T2DM patients. However, existing evidence suggests that among adult patients with T2DM, younger individuals (aged < 65 years) had higher rates of treatment intensification compared with elderly individuals.⁵ Other studies have found that intensification of treatment decreases with increasing age.^{5,6,24} Because of the lack of strong evidence that tight glycemic control is beneficial to older patients with T2DM, health care providers may not intensify treatment regimens in these patients.²⁵ Previous studies have demonstrated that older patients with T2DM had less treatment intensification compared with patients in other age groups.^{26,27} Future studies should examine if patient-physician factors influence treatment intensification among elderly patients with T2DM.

The current study found that the aHR for treatment intensification was lower for African American patients with T2DM compared with white patients, suggesting a significantly longer time to treatment intensification in this racial group. Again, owing to a lack of studies that focus exclusively on elderly patients with T2DM, the validity of the current study's findings with regard to race cannot be confirmed. Specific reasons for lower treatment intensification among African Americans were not directly examined in this study and can only be speculated. It has been suggested that physician behavior may be influenced by a patient's race/ethnicity,²⁸ which may have resulted in the longer time to treatment intensification among African American patients as seen in the current study. Furthermore, beliefs by African American patients about differential treatment from health care providers due to their race²⁹ and lack of trust in medical systems³⁰ may have translated into the longer time to treatment intensification for this racial group.

Given that half of the study population in the current study was censored without treatment intensification (defined as patients without dose escalation), our findings suggest a need for programs designed to promote treatment intensification in patients with T2DM. Several initiatives have been proven to reduce clinical inertia in diabetes management, most notably educational interventions among physicians that target cognitive barriers to medication initiation and intensification; clinical decision-support interventions using electronic medical record technology; and patient activation interventions.^{31,32} The low rates of treatment intensification among elderly patients with T2DM in the current study warrant the use of such interventions, specifically tailored to elderly patients.

Limitations

The study findings must be interpreted in the context of some limitations. As this was an observational, retrospective cohort study, the data may be subject to confounding and selection bias. The presence of a claim for filled prescriptions does not indicate if the medication was actually consumed or if it was taken as prescribed. Our dose escalation measurement may be an overestimation because we considered dose increases of even 1 OAD or in a single prescription. The presence of an ICD-9-CM diagnosis code on a medical claim may not necessarily signify the positive presence of disease, as the diagnosis might have been incorrectly coded or included as a rule-out criterion rather than as the actual disease. Finally, the analysis was based on data from a managed care population and may not be representative of other populations or generalizable to all Medicare beneficiaries with T2DM.

However, the strengths of this study are many and include its use of a nationwide database of Humana MAPD beneficiaries, examination of factors associated with treatment intensification in elderly patients with inadequately controlled T2DM (enabled by access to laboratory data on A1c levels), adjustments to a comprehensive list of independent variables, assessment of patient complexities, and inclusion of dose escalation based on drug names and potencies.

Conclusions

The current study makes a unique contribution to the existing literature on treatment intensification for patients with inadequately controlled diabetes by exclusively focusing on elderly patients (aged ≥ 65 years) seeking care in real-world practice settings. Also, it assesses the association between treatment intensification and elderly-specific patient complexities; clinical, demographic, and insurance characteristics; and health care use. The current study found that nearly half of elderly patients with T2DM did not receive treatment intensification over a 5-year period, and that elderly-specific patient complexities did not negatively affect time to treatment intensification. Further studies are warranted to examine why some subgroups of patients with uncontrolled T2DM, such as those aged ≥ 75 years and African American patients, had lower treatment intensification rates and had to wait longer to receive treatment intensification.

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References

1. Nathan DM, Buse JB, Davidson MB, et al. Management of hyperglycemia in type 2 diabetes: A consensus algorithm for the initiation and adjustment of therapy: a consensus statement from the American Diabetes Association and the European Association for the Study of Diabetes. *Diabetes Care*. 2006; 29(8):1963–72. Available at: <http://care.diabetesjournals.org/content/29/8/1963.full.pdf+html>. [PubMed: 16873813]

2. Ismail-Beigi F, Craven T, Banerji MA, et al. Effect of intensive treatment of hyperglycaemia on microvascular outcomes in type 2 diabetes: an analysis of the ACCORD randomised trial. *Lancet*. 2010; 376(9739):419–30. [PubMed: 20594588]
3. O'Connor PJ, Ismail-Beigi F. Near-normalization of glucose and microvascular diabetes complications: data from ACCORD and ADVANCE. *Ther Adv Endocrinol Metab*. 2011; 2(1):17–26. [PubMed: 23148169]
4. Wei NJ, Wexler DJ, Nathan DM, Grant RW. Intensification of diabetes medication and risk for 30-day readmission. *Diabet Med*. 2013; 30(2):e56–62. [PubMed: 23126686]
5. Chaudhry SI, Berlowitz DR, Concato J. Do age and comorbidity affect intensity of pharmacological therapy for poorly controlled diabetes mellitus? *J Am Geriatr Soc*. 2005; 53(7):1214–16. [PubMed: 16108941]
6. Fu AZ, Qiu Y, Davies MJ, Radican L, Engel SS. Treatment intensification in patients with type 2 diabetes who failed metformin monotherapy. *Diabetes Obes Metab*. 2011; 13(8):765–69. [PubMed: 21457427]
7. Nathan DM, Buse JB, Davidson MB, et al. Medical management of hyperglycemia in type 2 diabetes: a consensus algorithm for the initiation and adjustment of therapy: a consensus statement of the American Diabetes Association and the European Association for the Study of Diabetes. *Diabetes Care*. 2009; 32(1):193–203. Available at: <http://care.diabetesjournals.org/content/32/1/193.full.pdf+html>. [PubMed: 18945920]
8. Rodondi N, Peng T, Karter AJ, et al. Therapy modifications in response to poorly controlled hypertension, dyslipidemia, and diabetes mellitus. *Ann Intern Med*. 2006; 144(7):475–84. [PubMed: 16585661]
9. Lafata JE, Dobie EA, Divine GW, Ulcickas Yood ME, McCarthy BD. Sustained hyperglycemia among patients with diabetes: what matters when action is needed? *Diabetes Care*. 2009; 32(8):1447–52. Available at: <http://care.diabetesjournals.org/content/32/8/1447.full.pdf+html>. [PubMed: 19638524]
10. American Diabetes Association. [Accessed October 20, 2015] Statistics about Diabetes. Data from the. National Diabetes Statistics Report. 2014. (released June 10, 2014). Available at: <http://www.diabetes.org/diabetes-basics/statistics/>
11. Kirkman SM, Briscoe VJ, Clark N, et al. Diabetes in older adults: a consensus report. *J Am Geriatr Soc*. 2012; 60(12):2342–56. Available at: <http://onlinelibrary.wiley.com/doi/10.1111/jgs.12035/epdf>. [PubMed: 23106132]
12. Young BA, Lin E, Von Korff M, et al. Diabetes complications severity index and risk of mortality, hospitalization, and healthcare utilization. *Am J Manag Care*. 2008; 14(1):15–23. Available at: <http://www.ajmc.com/publications/issue/2008/2008-01-vol14-n1/Jan08-2781p15-23/>. [PubMed: 18197741]
13. Chang HY, Weiner JP, Richards TM, Bleich SN, Segal JB. Validating the adapted Diabetes Complications Severity Index in claims data. *Am J Manag Care*. 2012; 18(11):721–26. Available at: <http://www.ajmc.com/publications/issue/2012/2012-11-vol18-n11/Validating-the-Adapted-Diabetes-Complications-Severity-Index-in-Claims-Data/>. [PubMed: 23198714]
14. Ginde AA, Blanc PG, Lieberman RM, Camargo CA Jr. Validation of ICD-9-CM coding algorithm for improved identification of hypoglycemia visits. *BMC Endocr Disord*. 2008; 8:4. Available at: <http://www.biomedcentral.com/content/pdf/1472-6823-8-4.pdf>. [PubMed: 18380903]
15. Piette JD, Kerr EA. The impact of comorbid chronic conditions on diabetes care. *Diabetes Care*. 2006; 29(3):725–31. Available at: <http://care.diabetes-journals.org/content/29/3/725.full.pdf+html>. [PubMed: 16505540]
16. Mehta S, Chen H, Johnson ML, Aparasu RR. Risk of falls and fractures in older adults using antipsychotic agents: a propensity-matched retrospective cohort study. *Drugs Aging*. 2010; 27(10):815–29. [PubMed: 20883062]
17. Tinetti ME, Gordon C, Sogolow E, Lapin P, Bradley EH. Fall-risk evaluation and management: challenges in adopting geriatric care practices. *Gerontologist*. 2006; 46(6):717–25. Available at: <http://gerontologist.oxford-journals.org/content/46/6/717.full.pdf+html>. [PubMed: 17169927]

18. Goldberg JF, Brooks JO 3rd, Kurita K, et al. Depressive illness burden associated with complex polypharmacy in patients with bipolar disorder: findings from the STEP-BD. *J Clin Psychiatry*. 2009; 70(2):155–62. [PubMed: 19210946]
19. Anger JT, Saigal CS, Madison R, Joyce G, Litwin MS. Urologic Diseases of America Project. Increasing costs of urinary incontinence among female Medicare beneficiaries. *J Urol*. 2006; 176(1):247–51. [PubMed: 16753411]
20. Rich JT, Neely JG, Paniello RC, Voelker CC, Nussenbaum B, Wang EW. A practical guide to understanding Kaplan-Meier curves. *Otolaryngol Head Neck Surg*. 2010; 143(3):331–36. [PubMed: 20723767]
21. Abraham JM, Marmor S, Knutson D, Zeglin J, Virnig B. Variation in diabetes care quality among Medicare advantage plans: understanding the role of case mix. *Am J Med Qual*. 2012; 27(5):377–82. [PubMed: 22205769]
22. Gold M. Medicare's private plans: a report card on Medicare Advantage. *Health Aff (Millwood)*. 2009; 28(1):w41–54. Available at: <http://content.healthaffairs.org/content/28/1/w41.full.pdf+html>. [PubMed: 19029152]
23. Willey CJ, Andrade SE, Cohen J, Fuller JC, Gurwitz JH. Polypharmacy with oral antidiabetic agents: an indicator of poor glycemic control. *Am J Manag Care*. 2006; 12(8):435–40. Available at: <http://www.ajmc.com/publications/issue/2006/2006-08-vol12-n8/Aug06-2339p435-440/>. [PubMed: 16886886]
24. Higdon R, Stewart E, Roach JC, et al. Predictive analytics in healthcare: medications as a predictor of medical complexity. *Big Data*. 2013; 1(4):237–44. Available at: <http://online.liebertpub.com/doi/pdf/10.1089/big.2013.0024>.
25. Whitmer RA, Karter AJ, Yaffe K, Quesenberry CP Jr, Selby JV. Hypoglycemic episodes and risk of dementia in older patients with type 2 diabetes mellitus. *JAMA*. 2009; 301(15):1565–72. Available at: <http://jama.jamanetwork.com/article.aspx?articleid=183750>. [PubMed: 19366776]
26. Smith NL, Savage PJ, Heckbert SR, et al. Glucose, blood pressure, and lipid control in older people with and without diabetes mellitus: the Cardiovascular Health Study. *J Am Geriatr Soc*. 2002; 50(3):416–23. [PubMed: 11943034]
27. Grover SA, Coupal L, Zowall H, Dorais M. Cost-effectiveness of treating hyperlipidemia in the presence of diabetes: who should be treated? *Circulation*. 2000; 102(7):722–27. Available at: <http://circ.ahajournals.org/content/102/7/722.full.pdf+html>. [PubMed: 10942738]
28. Van Ryn M. Research on the provider contribution to race/ethnicity disparities in medical care. *Med Care*. 2002; 40(1 Suppl):I140–51. [PubMed: 11789627]
29. Johnson RL, Saha S, Arbelaez JJ, Beach MC, Cooper LA. Racial and ethnic differences in patient perceptions of bias and cultural competence in health care. *J Gen Intern Med*. 2004; 19(2):101–10. [PubMed: 15009789]
30. Traylor AH, Subramanian U, Uratsu CS, Mangione CM, Selby JV, Schmittiel JA. Patient race/ethnicity and patient-physician race/ethnicity concordance in the management of cardiovascular disease risk factors for patients with diabetes. *Diabetes Care*. 2010; 33(3):520–25. Available at: <http://care.diabetesjournals.org/content/33/3/520.full.pdf+html>. [PubMed: 20009094]
31. Sperl-Hillen JM, O'Connor PJ, Rush RW, et al. Simulated physician learning program improves glucose control in adults with diabetes. *Diabetes Care*. 2010; 33(8):1727–33. Available at: <http://care.diabetesjournals.org/content/33/8/1727.full.pdf+html>. [PubMed: 20668151]
32. Greenfield S, Kaplan SH, Ware JE Jr, Yano EM, Frank HJ. Patients' participation in medical care: effects on blood sugar control and quality of life in diabetes. *J Gen Intern Med*. 1988; 3(5):448–57. [PubMed: 3049968]

APPENDIX ICD-9-CM Diagnosis Codes

Disease Conditions	ICD-9-CM Codes
Diabetes Complications Severity Index	

Disease Conditions	ICD-9-CM Codes
Retinopathy	
Diabetic ophthalmologic disease	250.5x
Background retinopathy	362.01
Other retinopathy	362.1
Retinal edema	362.83
Cystoid macular edema/degeneration	362.53
Other retinal disorders	362.81, 362.82
Proliferative retinopathy	362.02
Retinal detachment	361.xx
Blindness	369.xx
Vitreous hemorrhage	379.23
Nephropathy	
Diabetic nephropathy	250.4
Acute glomerulonephritis	580
Nephrotic syndrome	581
Hypertension, nephrosis	581.81
Chronic glomerulonephritis	582
Nephritis/nephropathy	583
Chronic renal failure	585
Renal failure, not otherwise specified	586
Renal insufficiency	593.9
Neuropathy	
Diabetic neuropathy	356.9, 250.6
Amyotrophy	358.1
Cranial nerve palsy	951.0, 951.1, 951.3
Mononeuropathy	354.0–355.9
Charcot's arthropathy	713.5
Polyneuropathy	357.2
Neurogenic bladder	596.54
Autonomic neuropathy	337.0, 337.1
Gastroparesis/diarrhea	564.5, 536.3
Orthostatic hypotension	458.0
Cerebrovascular	
Transient ischemic attack	435
Stroke	431, 433, 434, 436
Cardiovascular disease	
Atherosclerosis	440.xx
Other ischemic heart disease	411
Angina pectoris	413

Disease Conditions	ICD-9-CM Codes
Other chronic ischemic heart disease	414
Myocardial infarction	410
Ventricular fibrillation, arrest	427.1, 427.3
Atrial fibrillation, arrest	427.4, 427.5
Other atherosclerotic cardiovascular disease	429.2
Old myocardial infarction	412
Heart failure	428
Atherosclerosis, severe	440.23, 440.24
Aortic aneurysm/dissection	441
Peripheral vascular disease	
Diabetic peripheral vascular disease	250.7
Other aneurysm, lower extremity	442.3
Peripheral vascular disease	443.81, 443.9
Foot wound + complications	892.1
Claudication, intermittent	443.9
Peripheral vascular disease	
Embolism/thrombosis, lower extremity	444.22
Gangrene	785.4
Gas gangrene	0.40
Ulcer of lower limbs	707.1
Metabolic	
Ketoacidosis	250.1
Hyperosmolar	250.2
Other coma	250.3
Elderly-Specific Patient Complexities	
Cognitive impairment	
Delirium, dementia, and amnesic and other cognitive disorders	290.0x, 290.10, 290.11, 290.12, 290.13, 290.20, 290.21, 290.3, 290.40, 290.41, 290.42, 290.43, 290.8, 290.9, 293.0, 293.1, 294.0, 294.1, 294.10, 294.11, 294.8, 294.9, 310.0, 310.2, 310.8, 310.9, 331.0, 331.1, 331.11, 331.19, 331.2, 331.82, 797.xx
Huntington's disease	333.4
Parkinson's disease	332.xx
Schizophrenia and other psychotic disorders	293.8, 293.82, 295.00, 295.01, 295.02, 295.03, 295.04, 295.05, 295.10, 295.11, 295.12, 295.13, 295.14, 295.15, 295.20, 295.21, 295.22, 295.23, 295.24, 295.25, 295.30, 295.31, 295.32, 295.33, 295.34, 295.35, 295.40, 295.41, 295.42, 295.43, 295.44, 295.45, 295.50, 295.51, 295.52, 295.53, 295.54, 295.55, 295.60, 295.61, 295.62, 295.63, 295.64, 295.65, 295.70, 295.71, 295.72, 295.73, 295.74, 295.75, 295.80, 295.81, 295.82, 295.83, 295.84, 295.85, 295.90, 295.91, 295.92, 295.93, 295.94, 295.95, 297.0, 297.1, 297.2, 297.3, 297.8, 297.9, 298.0, 298.1, 298.2, 298.3, 298.4, 298.8, 298.9
Bipolar disorder	296.00, 296.01, 296.02, 296.03, 296.04, 296.05, 296.06, 261.0, 296.11, 296.12, 296.13, 296.1, 296.15,

Disease Conditions	ICD-9-CM Codes
	296.16, 296.40, 296.41, 296.42, 296.43, 296.44, 296.45, 296.46, 296.50, 296.51, 296.52, 296.53, 296.54, 296.55, 296.56, 296.60, 296.61, 296.62, 296.63, 296.64, 296.65, 296.66, 296.7, 296.80, 296.81, 296.82, 296.89, 296.90, 296.99
Urinary incontinence	
Urinary incontinence	788.3
Urinary incontinence unspecified	788.30
Urge incontinence	788.31
Mixed incontinence, male, female	788.33
Incontinence without sensory awareness	788.34
Continuous leakage	788.37
Falls and fall risk	
Falls	E880 through E888
Fall risk	V15.88
Mental illness	
Depression	293.83, 296.20, 296.21, 296.22, 296.23, 296.24, 296.25, 296.26, 296.30, 296.31, 296.32, 296.33, 296.34, 296.35, 296.36, 300.4, 311.xx

ICD-9-CM = International Classification of Diseases, Ninth Revision, Clinical Modification.

What is already known about this subject

- Among individuals with type 2 diabetes mellitus (T2DM), treatment intensification with insulin is needed to prevent diabetes complications among elderly patients who failed to achieve glycemic control.
- Risk factors specific to elderly patients may facilitate or act as barriers to treatment intensification with insulin.

What this study adds

- We show that elderly-specific patient complexities are not associated with time to treatment intensification.
- These findings emphasize a positive effect on the integrated health care delivery model.
- Emerging health care delivery models that target integrated care may therefore be crucial in providing appropriate treatment for elderly T2DM patients with complex conditions.

FIGURE 1.

Study Cohort Selection Chart

A1c = hemoglobin A1c; GLP-1 = glucagon-like peptide-1; MAPD = Medicare Advantage Prescription Drugs; OADs = oral antidiabetes drugs; T2DM = type 2 diabetes mellitus.

TABLE 1

Description of Median Time to Treatment Intensification in T2DM Patients with Uncontrolled Diabetes: Results from Kaplan-Meier Product Limit Estimates Using Humana MAPD Data 2007–2012

	N	Censored	% Censored	Median Time, Months	95% CI	P Value
All	16,653	8,550	51.3	18.5	17.7–19.3	
Demographic and insurance characteristics						
Age						< 0.001
65–74 years	10,620	5,293	49.8	17.4	16.5–18.3	
75 years	6,033	3,257	54.0	20.9	19.2–22.5	
Sex						0.966
Women	8,102	4,123	50.9	18.4	17.4–19.8	
Men	8,551	4,427	51.8	18.6	17.4–19.5	
Race						< 0.001
White	11,559	5,747	49.7	17.1	16.2–18.0	
African American	3,305	1,807	54.7	23.9	21.9–26.7	
Hispanic	664	334	50.3	17.3	14.4–23.1	
Other	1,125	662	58.8	20.0	17.1–25.2	
U.S. region						< 0.001
Midwest	1,861	932	50.1	16.8	14.4–18.9	
South	13,226	6,863	51.9	19.3	18.3–20.1	
Northeast/Northwest/Other	1,566	755	48.2	14.5	12.6–16.8	
Insurance type						< 0.001
HMO	10,986	5,730	52.2	20.9	19.8–21.9	
PPO	2,825	1,516	53.7	14.8	13.5–16.5	
FFS	2,658	1,201	45.2	14.8	13.5–16.2	
Other	184	103	56.0	17.2	12.3–23.7	
Donut hole						< 0.001
Pre-donut hole	15,189	7,938	52.3	19.6	18.6–20.4	
In donut hole	1,337	562	42.0	11.4	9.9–12.6	
Post-donut hole	127	50	39.4	11.1	6.0–16.8	

	N	Censored	% Censored	Median Time, Months	95% CI	P Value
Baseline health care utilization						
Inpatient visits						0.020
Yes	1,947	984	50.5	16.6	15.0–18.3	
No	14,706	7,566	51.5	18.8	18.0–19.8	
Emergency department visits						0.020
Yes	1,476	736	49.9	16.6	14.4–19.5	
No	15,177	7,814	51.5	18.6	18.0–19.5	
Number of outpatient visits						< 0.001
0	8,058	4,161	51.6	18.6	17.7–20.1	
1–2	4,209	2,229	53.0	20.7	18.9–22.5	
3	4,386	2,160	49.2	16.6	15.3–17.7	
Clinical characteristics						
DCSI categories						0.308
0	5,693	2,987	52.5	19.4	18.0–21.0	
1–2	2,875	1,425	49.6	17.5	15.9–19.2	
3	4,990	2,568	51.5	18.6	17.1–20.1	
4–12	3,095	1,570	50.7	17.7	16.2–19.5	
Hypoglycemia						0.952
Yes	516	279	54.1	18.9	15.0–27.0	
No	16,137	8,271	51.3	18.5	17.7–19.2	
A1c categories						< 0.001
8.0% to < 8.5%	8,970	5,000	55.7	23.2	22.2–24.3	
8.5% to < 9.0%	2,575	1,300	50.5	16.9	15.3–18.9	
9.0%	5,108	2,250	44.0	12.1	11.4–12.9	
Discordant condition (COPD)						0.352
Yes	7,762	3,997	51.5	17.7	16.5–18.6	
No	8,891	4,553	51.2	19.2	18.3–20.4	
Dominant condition (cancer)						0.495
Yes	1,493	793	53.1	18.9	16.5–21.9	

	N	Censored	% Censored	Median Time, Months	95% CI	P Value
No	15,160	7,757	51.2	18.5	17.7–19.2	
Elderly-specific patient complexities						
Cognitive impairment						0.449
Yes	1,634	849	52.0	17.3	15.3–20.4	
No	15,019	7,701	51.3	18.6	17.7–19.5	
Depression						0.494
Yes	1,072	546	50.9	17.4	15.3–20.4	
No	15,581	8,004	51.4	18.6	17.7–19.5	
Falls and fall risk						0.018
Yes	217	97	44.7	12.7	10.2–16.2	
No	16,436	8,453	51.4	18.6	17.7–19.5	
Polypharmacy						< 0.001
6 drugs	9,306	4,889	52.5	20.4	19.2–21.9	
> 6 drugs	7,347	3,661	49.8	16.5	15.6–17.4	
Urinary incontinence						0.028
Yes	16,318	8,393	51.4	18.6	17.7–19.2	
No	335	157	46.9	14.6	10.8–18.6	

Note: Based on data from the Humana MAPD plan database of 16,653 elderly patients with T2DM who had treatment intensification during the assessment period (January 2007 to June 2012).

A1c = hemoglobin A1c; CI = confidence interval; COPD = chronic obstructive pulmonary disease; DCSI = Diabetes Complications Severity Index; FFS = fee-for-service; HMO = health maintenance organization; MAPD = Medicare Advantage Prescription Drugs; PPO = preferred provider organization; T2DM = type 2 diabetes mellitus.

TABLE 2

Description of Rates of Treatment Intensification at Variable Lengths of Follow-up by Age Groups in T2DM Patients with Uncontrolled Diabetes: Humana MAPD Data 2007–2012^a

Follow-up Time	Treatment Intensification		Type of Treatment Intensification Among Those Intensified	
	N	%	Addition of Third OAD (%)	Insulin (%)
All				
4 months	3,911	23.5	60.9	39.1
6 months	4,632	27.8	60.1	39.9
12 months	6,145	36.9	59.8	40.2
24 months	7,445	44.7	59.3	40.7
Overall	8,103	48.7	58.7	41.3
Age group: 65–74 years				
4 months	2,566	24.2	62.0	38.0
6 months	3,044	28.7	61.6	38.4
12 months	4,022	37.9	61.5	38.5
24 months	4,877	45.9	60.9	39.1
Overall	5,327	50.2	60.3	39.7
Age group: 75 years				
4 months	1,345	22.3	58.6	41.4
6 months	1,588	26.3	57.2	42.8
12 months	2,123	35.2	56.7	43.3
24 months	2,568	42.6	56.4	43.6
Overall	2,776	46.0	55.5	44.5

Note: Based on data from the Humana MAPD plan database of 16,653 elderly patients with T2DM who had treatment intensification during the assessment period (January 2007 to June 2012).

^a Rates of treatment intensification significantly ($P < 0.001$) differed between age groups 65–74 years and 75 years when measured using chi-square tests.

MAPD = Medicare Advantage Prescription Drugs; OAD = oral antidiabetes drug; T2DM = type 2 diabetes mellitus.

TABLE 3

Adjusted Hazard Ratios for Multivariable Cox-Proportional Hazards Regression for Treatment Intensification in T2DM Patients with Uncontrolled Diabetes: Humana MAPD Data 2007–2012

	aHR	95% CI	P Value
Demographic and insurance characteristics			
Age			
65–74 years	Ref.	Ref.	
75 years	0.90	0.86–0.94	< 0.001
Sex			
Women	1.04	0.99–1.08	0.345
Men	Ref.	Ref.	
Race			
White	Ref.	Ref.	
African American	0.83	0.79–0.89	< 0.001
Hispanic	0.97	0.87–1.09	0.870
Other	0.91	0.83–1.00	0.087
U.S. region			
Midwest	0.93	0.85–1.03	0.199
South	0.88	0.82–0.95	< 0.001
Northeast/Northwest/other	Ref.	Ref.	
Insurance type			
HMO	0.85	0.80–0.91	< 0.001
PPO	1.00	0.92–1.07	0.872
FFS	Ref.	Ref.	
Other	0.90	0.72–1.13	0.347
Donut hole			
Pre- and post-donut hole	0.75	0.70–0.81	< 0.001
In donut hole	Ref.	Ref.	
Baseline health care utilization			
Inpatient visits			
Yes	0.98	0.91–1.06	0.966
No	Ref.	Ref.	
Emergency department visits			
Yes	1.02	0.93–1.11	0.479
No	Ref.	Ref.	
Number of outpatient visits			
0	Ref.	Ref.	
1–2	0.96	0.91–1.02	0.150
3	1.09	1.03–1.15	0.021
Clinical characteristics			

	aHR	95% CI	P Value
DCSI categories			
0	Ref.	Ref.	
1–2	1.07	1.00–1.14	0.051
3	1.05	0.99–1.11	0.126
4–12	1.09	1.02–1.17	0.025
Hypoglycemia			
Yes	0.99	0.87–1.13	0.0702
No	Ref.	Ref.	
Baseline A1c categories			
8.0% to < 8.5%	Ref.	Ref.	
8.5% to < 9.0%	1.20	1.12–1.27	< 0.001
9.0%	1.51	1.44–1.59	< 0.001
Discordant condition (COPD)			
Yes	0.99	0.94–1.03	0.512
No	Ref.	Ref.	
Dominant condition (cancer)			
Yes	1.00	0.92–1.08	0.750
No	Ref.	Ref.	
Elderly-specific patient complexities			
Cognitive impairment			
Yes	0.97	0.86–1.09	0.898
No	Ref.	Ref.	
Depression			
Yes	1.02	0.88–1.18	0.946
No	Ref.	Ref.	
Falls and fall risk			
Yes	1.16	0.96–1.39	0.098
No	Ref.	Ref.	
Polypharmacy			
6 drugs	Ref.	Ref.	
> 6 drugs	1.10	1.04–1.15	< 0.001
Urinary incontinence			
Yes	1.13	0.97–1.31	0.102
No	Ref.	Ref.	

Note: Based on data from the Humana MAPD plan database of 16,653 elderly patients with T2DM who had treatment intensification during the assessment period (January 2007 to June 2012).

A1c = hemoglobin A1c; aHR=adjusted hazard ratio; CI = confidence interval; COPD = chronic obstructive pulmonary disease; DCSI = Diabetes Complications Severity Index; FFS = fee-for-service; HMO = health maintenance organization; MAPD = Medicare Advantage Prescription Drugs; PPO = preferred provider organization; Ref. = reference; T2DM = type 2 diabetes mellitus.