ORIGINAL ARTICLE

Mortality and Macrovascular Risk in Elderly With Hypertension and Diabetes: Effect of Intensive Drug Therapy

Arseniy P. Yashkin,[1] Julia Kravchenko,[2] Anatoliy I. Yashin,[1] and Frank Sloan[3]

BACKGROUND
This study identifies the effect of intensive drug therapy (IDT) in individuals age 65+ with diabetes (type 2 diabetes mellitus (T2D)) and hypertension on all-cause death, congestive heart failure (CHF), hospitalization for myocardial infarction (MI), and stroke or transient ischemic attack (TIA).

METHODS
Individuals from the Medicare 5% dataset with hypertension and T2D undergoing IDT for these conditions were propensity score matched to a nonintensive drug-therapy group. Hazard ratios (HRs) were obtained using the Cox proportional hazard model.

RESULTS
IDT was associated with increased risk of CHF (HR 2.32; 95% confidence interval (CI) 2.32–2.38), MI (HR 4.27; 95% CI 4.05–4.52), and stroke or TIA (HR 1.80; 95% CI 1.70–1.89) but decreased risk of death (HR 0.95; 95% CI 0.93–0.97). Risk for CHF (HR 0.73; 95% CI 0.71–0.73), MI (HR 0.64; 95% CI 0.62–0.67), stroke or TIA (HR 0.82; 95% CI 0.78–0.86), and death (HR 0.29; 95% CI 0.28–0.29) was decreased by adherence to diabetes management guidelines.

CONCLUSIONS
Use of IDT in a high-risk population delays death but not severe macrovascular outcomes. Protective effects of IDT in high-risk patients likely outweigh polypharmacy-related health concerns.

Keywords: adherence; blood pressure; diabetes mellitus; hypertension; intensive drug therapy; macrovascular outcomes; mortality.

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Recent research suggests a possible association between intensive drug therapy (IDT) and a wide range of negative health outcomes, including inappropriate use of individual medications, unexpected adverse drug–drug interactions, interactions between an individual drug and an existing comorbid condition, physical function limitations, cognitive impairment, and nonadherence to life-saving treatment regimens.[1–3] However, pharmacotherapy is a cornerstone in the management of many acute and chronic diseases and has been contributing to improvements in Public Health at least as far back as the development of penicillin. Therefore, any potential risk associated with taking legitimately prescribed medication may be outweighed by the benefit received from treating the already present health condition.

Diabetes mellitus, type 2 (T2D), is a serious chronic condition that accounts for over 90% of all diagnosed diabetes in the United States[4] and is linked to increased mortality and complication rates in several organ systems.[5] Recent estimates place the prevalence of T2D in individuals aged 65+ at over 25%.[6,7] About three-fourths of such individuals are also diagnosed with hypertension.[4] The pathophysiological trajectories of these 2 chronic conditions are concordant[4] and represent substantial risk factors for many major cerebro-/cardiovascular complications.[8–12] Furthermore, recent studies suggest that the prevalence rates for both of these diseases are expected to continue to increase.[13–15]

T2D alone increases the risk of premature death from cardiovascular disease by 70–80%,[4] but a person with both T2D and hypertension faces an increased mortality risk of 400%.[4] Furthermore, individuals aged 65+ with T2D often have a high number of additional comorbidities (in 1 study, a median of 5), which increases the complexity of disease management[16] and leads to the use of multiple prescribed drugs.[17,18] Antidiabetic, diuretic, and other antihypertensive agents are among the most frequently used medications by Medicare beneficiaries.[19] This high rate of use by elderly persons with T2D[17] and hypertension may, on the one hand, reflect excessive or unwarranted use of multiple prescription medications.[3,20] Alternatively, such IDT may be beneficial to these patients by reducing risk of adverse health outcomes associated with T2D.[21]

In this study, we concentrate on identifying the effect of IDT in Medicare beneficiaries age 65+ diagnosed with both T2D and hypertension on a select set of outcomes of special relevance to this population. This fairly specific focus has been chosen in order to limit the sheer variety of prescription and over the counter substances that individuals may take for a wide range of diseases to a tightly defined

Correspondence: Arseniy P. Yashkin (apy4@duke.edu).

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[1]Biodemography of Aging Research Unit, Center for Population Health and Aging, Duke University, Durham, North Carolina, USA; [2]Department of Surgery, Duke University School of Medicine, Durham, North Carolina, USA; [3]Department of Economics, Duke University, Durham, North Carolina, USA.

population with well-documented risk for both the behavior of interest and 4 adverse health outcomes: death, congestive heart failure (CHF), hospitalization for myocardial infarction (MI), and hospitalization for stroke or transient ischemic attack (TIA).

METHODS

Data for this study came from public use files provided by the US Centers for Medicare and Medicaid Services containing a nationally representative 5% sample of episodes of care paid for by the Medicare social insurance system between 2003 and 2012. Medicare Part A and B claims provided information on diagnoses made (International Classification of Disease 9th Edition, Clinical Modification (ICD-9)) and procedures performed (International Classification of Disease 9th Edition, Clinical Modification procedure and/or Current Procedural Terminology 4th Edition codes) in both institutional (Part A) settings and by health professionals (Part B) as well as the specialty of the claim-generating physician. Medicare Part D data, available since 2006, the year Part D was first implemented, provided information on prescription drugs obtained by Medicare beneficiaries. The Part D data contained information on both brand and generic versions of each drug.

Medicare data are not nationally representative of individuals under the age of 65 and do not collect claims data for beneficiaries who enroll in Medicare Advantage, a private alternative to traditional fee-for-service Medicare, or for those who reside outside of the geographical borders of the United States. Therefore, individuals meeting the above criteria were excluded. Furthermore, we required that each individual chosen for the sample has at least 3 full years of look-back data from the baseline date in order to identify the presence of preexisting health conditions. Baseline was defined as 1 January 2006 if a confirmed diagnosis of T2D and hypertension (2 claims with the respective diagnosis within a 180-day period) appeared on claims for services rendered between 1 January 2003 and 31 December 2005. For all confirmed diagnoses made on or after 1 January 2006, the date associated with the claim was used. At least 1 full year of follow-up data and at least 1 claim for a drug to treat diabetes or hypertension (Table 1) was also required. Beneficiaries with claims for the study diagnoses (e.g., CHF, MI, and stroke or TIA) in the 3-year look-back period were excluded from the corresponding complication-specific analysis but included in the analysis of mortality.

Beneficiaries were followed in 1-year intervals, starting with the baseline date and ending when the beneficiary either experienced a study outcome or exited the data. All variables were updated at the beginning of each 1-year period. The initial sample pool included a total of 910,880 observations with each observation corresponding to a beneficiary year. The rationale for dividing the data into beneficiary-year observational units was to allow for intertemporal variation in drug use and in other time-varying covariates. Given that an individual could contribute up to 6 person-years to the sample, the standard procedure of using a hazard with a single baseline at which all covariates are measured and not allowed to change over time was considered inappropriate. We accounted by clustering using the Huber-White procedure.

Dependent variables were time to death or the first diagnosis of each of the 3 health outcomes. The primary explanatory variable was IDT. A beneficiary was considered undergoing IDT if he/she filled a prescription for 5+ distinct drug categories from the antidiabetic or antihypertension lists (Table 1). Drugs were aggregated at the category level, thus being prescribed 3 different types of diuretics, for example, counted as 1 drug, whereas a diuretic and a calcium channel blocker combination counted as 2 drugs.

A critical component of T2D management that cannot be overlooked is adherence to physician practice guidelines such as those published by the American Diabetes Association.[22] Adherence to such guidelines has been shown to reduce the risk of death and many complications of T2D. However, they may also be argued to contribute to adverse health outcomes. For example, results of regular HBA1c tests specified in the guidelines may lead to additional, unwarranted antidiabetic agents being prescribed[3] or an adverse drug reaction identified at a guideline-suggested checkup may be misinterpreted as a new medical condition leading to the prescription of additional medication, a phenomenon known as a "prescribing cascade."[2] We include a measure of American Diabetes Association screening guidelines by aggregating information on 7 guideline-suggested screening behaviors. Information on whether a beneficiary had a blood pressure, urine, HBA1c, and lipid test performed was identified by querying the claims data for the appropriate Current Procedural Terminology 4th Edition code (Table 1). Visits to a physician, eye care specialist (optometrist or ophthalmologist), or other T2D specialist physician were identified from the US Centers for Medicare and Medicaid physician specialty code associated a Medicare claim. Visits to eye care specialists were treated as a separate category since American Diabetes Association guidelines recommend eye exams on an annual basis, independent of whether the patient experiences symptoms. Factor analysis was conducted to convert the 7 measures of health services use into a single adherence index. The first factor was selected since it was the only factor with an eigenvalue above 1.0 (Table 2). Loadings on all variables for the first factor were positive.

Other covariates used in our analysis were beneficiary age, male gender, race (black, other, white–omitted), Charlson index,[23] and binary variables for insulin dependence, lipidemia, cognitive impairment and 4 categories of other common complications of T2D: visual, lower extremity, renal, and cardiovascular (Table 1). We modified the Charlson index to exclude diagnoses that were included separately as covariates. A linear trend for the calendar year was included to account for changes in technology and practice patterns.

To assure that comparisons between beneficiaries in the IDT and the control group were comparable on observable characteristics, we used propensity score matching (PSM) based on all covariates used in this study.[24] We used logistic regression to estimate the propensity score (the probability of being in the IDT group) using nearest neighbor matching without replacement within a caliper of 0.001 to identify the match. Treatment (IDT) and control groups were considered

Table 1. List of study codes

Study inclusion requirements		
Diabetes mellitus	ICD-9	250.xx
Hypertension	ICD-9	401.xx
Study outcomes		
Congestive heart failure	ICD-9	428.xx 398.91 402.01 402.11 402.91 404.11 404.91
Myocardial infarction[a]	ICD-9	410.xx 412.xx
Stroke/transient ischemic attack[a]	ICD-9	430.xx 431.xx 432.xx 435.xx 436.xx
Insulin dependence	ICD-9	250.1x 250.3x 250.01 259.03
Lipidemia	ICD-9	272.0x–272.4x
Cognitive impairment		
Alzheimer's disease	ICD-9	331.0x 331.1x 331.2x 331.9x
Senility	ICD-9	797.xx
Dementia	ICD-9	290.xx 294.xx
Ocular complication		
Retinopathy	ICD-9	362.01–362.06 362.10
Macular edema	ICD-9	362.53 362.83 362.07
Vitreous hemorrhage	ICD-9	379.23
Rubeosis iridis	ICD-9	364.42
Low vision/blindness	ICD-9	369.xx V26.00 V26.10 V26.15
	CPT-4	92392
Lower extremity complication		
Diabetes/w neuropathy	ICD-9	250.6x 357.2 355.xx 362.02
Diabetic amyotrophy	ICD-9	358.1
Cellulitis	ICD-9	681.1x 682.6 682.7
Charcot foot	ICD-9	707.11
Osteomyelitis	ICD-9	730.06 730.07 730.16 730.17 730.26 730.27
Gangrene	ICD-9	250.7x 785.4
Amputation	ICD-9	84.1x 86.28
	CPT-4	27290 27295 27590–27592 27594–27596 27598 28820 28825 28800 28805 27884
		27880–27882 27886 27888 278810 11000 11001 11010 11011 11040–11042
Renal complication		
Diabetic nephropathy	ICD-9	250.04
Proteinuria	ICD-9	791.xx
Nephrotic syndrome	ICD-9	581.8x
Chronic renal failure	ICD-9	585.xx 404.12 404.13 404.92 404.93 403.01 403.11 403.91
Unspecified renal failure	ICD-9	586.xx
Transplant	ICD-9	V42.00 55.69
	CPT-4	50360 50365
Dialysis	ICD-9	V45.11 V56.xx 39.95 54.98
	CPT-4	90921 90925 90960 90961 90962 90966 90970 90935 90937 90945 90947
Cardiovascular complication		
Angina	ICD-9	413.xx
Carotid bruit	ICD-9	785.9

Table 1. *Continued*

Ischemic heart disease	ICD-9	411.xx 414.xx
Occlusion or stenosis	ICD-9	433.xx 434.xx
Elements of adherence to diabetes treatment guidelines		
General physician visit	CMS	*01 08 11 70 50 97*
Specialist physician visit	CMS	*46 39 06 48*
Eye Specialist visit	CMS	*18 41*
Blood pressure test	CPT-4	90201 90205 99211-99215 99241-99245 99301-99303 99311-99313 99321–99323
		99341-99349 99350 99387 99397 99401-99404 99411 99412 9942x 99331–99333
Urine test	CPT-4	81001–81005 82040 82042 82043 82044 84155
HBA1c test	CPT-4	82985 83036
Lipid test	CPT-4	80061 82465 83715-83719 83721 84478
Antidiabetes drugs[b]		
Metformin, sulfonylureas, meglitinides, thiazolidinediones, alpha glucosidase inhibitors, GLP1, agonists, DPP-IV inhibitors		
Antihypertension drugs[b]		
Diuretics, sympatholytics, ACE inhibitors, calcium channel blockers, angiotensin 2 antagonists, direct renin antagonists		

Abbreviations: ACE, angiotensin-converting-enzyme; ICD-9, International Classification of Disease 9th Edition, Clinical Modification; CPT, Current Procedural Terminology, 4th Edition; CMS, Centers for Medicare and Medicaid Services specialty codes; GLP, glucagon-like peptide.
[a]Includes Part A inpatient claims only. [b]Includes all brand and generic names in drug group.

Table 2. Adherence to American Diabetes Association screening guidelines

Factor component	Factor loading
General physician visit	0.04
Specialist physician visit	0.03
Eye care specialist visit	0.08
Urine test	0.18
HBA1c test	0.33
Lipid test	0.34
Blood pressure test	0.08
Factor eigenvalue[b]	1.12

[a]Varimax rotation was used. [b]Satisfies Kaiser Criterion for retaining the factor.

to be well-matched if the standardized difference on each covariate was less than 10%.[24,25] Beneficiaries who could not be matched on these criteria were dropped. After PSM, the analysis samples were 716,852 person-years for death, 487,443 for CHF, 678,210 for MI, and 683,076 for stroke or TIA.

A Cox proportional hazard model was used to analyze the relationship between IDT and the study outcomes. Stata 11 (StataCorp 2009; Stata Statistical Software: Release 11, StataCorp LP, College Station, TX) was used for the analysis.

RESULTS

Prior to matching, on average, the treatment group was substantially more adherent to guidelines, slightly younger, more likely to be insulin dependent and be diagnosed with lipidemia, less likely to be cognitively impaired, and more likely to have ocular, renal, or cardiovascular complications of T2D (Table 3). In other aspects, including presence of a lower extremity complication in the Charlson index, these treatment and control groups were similar with standardized differences well below 10%. After matching, all standardized differences were well below 10%.

IDT was associated with a reduced risk of death during the follow-up year of 5% (hazard ratio (HR) 0.95; 95% confidence interval (CI) 0.93–0.97) (Table 4). Adherence to guidelines was associated with reduced risk of death (HR 0.29; 95% CI 0.28–0.29). The difference in mean adherence scores for the mortality sample between the IDT and control groups prior to matching was 0.30 (see Table 3, panel A). Applying this difference to the HR for adherence in Table 4 yielded a predicted reduction in the probability of death during the follow-up year of 8.7%. Being black (HR 0.86; 95% CI 0.83–0.88) or other race (HR 0.80; 95% CI 0.77–0.83) was linked to a lower risk of death, whereas being male (HR 1.16; 95% CI 1.14–1.19) and older (HR 1.05; 95% CI 1.05–1.05) were associated with increased risk. Risk of death was positively related to the Charlson index (HR 1.25; 95% CI 1.25–1.25), insulin dependence (HR 1.52; 95% CI 1.49–1.55), cognitive impairment (HR 1.45; 95% CI 1.42–1.49), and T2D complications of the eye (HR 1.23; 95% CI 1.20–1.26), lower extremity (HR 1.24; 95% CI 1.21–1.27), renal (HR 1.66; 95% CI 1.62–1.69) and cardiovascular (HR 1.12; 95% CI 1.10–1.15) systems. Having a diagnosis of lipidemia (HR 0.89; 95% CI 0.87–0.90) was associated with lower mortality risk, probably because the diagnosis was recorded at the time a drug for this condition was first prescribed.

Table 3. Sample characteristics before and after propensity score matching

	Panel A: death						Panel B: congestive heart failure					
	Before matching			After matching			Before matching			After matching		
	Treatment group	Control group	Std. dif.	Treatment group	Control group	Std. dif.	Treatment group	Control group	Std. dif.	Treatment group	Control group	Std. dif.
Number of observations	445,222	499,165		358,456	358,456		281,294	365,905		243,810	243,810	
Adherence	0.31	0.01	**48.30**	0.23	0.23	−0.28	0.35	0.07	**48.59**	0.31	0.31	−0.32
Year	2009.33	2009.41	−4.48	2009.38	2009.38	0.07	2009.30	2009.39	−4.26	2009.34	2009.34	−0.16
Age	78.32	79.55	**−17.34**	78.64	78.61	0.35	77.40	78.68	**−18.78**	77.64	77.61	0.54
Male	0.32	0.32	1.74	0.32	0.32	−0.05	0.33	0.32	2.66	0.33	0.33	−0.18
Black	0.11	0.10	1.86	0.10	0.10	0.23	0.10	0.09	3.35	0.10	0.10	0.22
Other	0.09	0.08	1.52	0.09	0.09	−0.02	0.09	0.09	1.92	0.09	0.09	−0.23
Charlson index	1.68	1.56	6.05	1.60	1.59	0.40	1.46	1.40	3.44	1.41	1.41	0.40
Insulin dependence	0.32	0.22	**22.09**	0.26	0.26	0.92	0.28	0.19	**20.24**	0.24	0.24	0.88
Lipidemia	0.77	0.70	**15.77**	0.75	0.75	−0.46	0.77	0.71	**13.61**	0.76	0.76	−0.33
Cognitive impairment	0.14	0.20	**−15.92**	0.16	0.15	0.85	0.11	0.16	**−15.97**	0.11	0.11	1.21
Ocular complication	0.18	0.12	**17.43**	0.14	0.14	0.99	0.16	0.10	**16.62**	0.13	0.13	0.90
Lower Extremity complication	0.70	0.66	8.93	0.68	0.68	0.53	0.64	0.61	6.20	0.62	0.62	0.60
Renal complication	0.24	0.18	**15.11**	0.21	0.20	0.80	0.18	0.13	**13.48**	0.16	0.16	0.76
Cardiovascular complication	0.52	0.41	**22.69**	0.46	0.45	0.63	0.44	0.35	**19.57**	0.40	0.40	0.77
	Panel C: myocardial infarction						Panel D: stroke/transient ischemic attack					
Number of observations	412,534	483,081		339,212	339,212		420,981	477,977		341,610	341,610	
Adherence	0.31	0.01	49.15	0.24	0.24	−0.25	0.31	0.02	**48.32**	0.24	0.24	−0.22
Year	2009.31	2009.40	−4.79	2009.36	2009.36	−0.03	2009.32	2009.41	−4.39	2009.37	2009.37	−0.15
Age	78.22	79.50	**−18.04**	78.52	78.49	0.50	78.21	79.44	**−17.42**	78.51	78.48	0.44
Male	0.32	0.31	1.52	0.32	0.32	−0.09	0.33	0.32	2.20	0.33	0.33	−0.14
Black	0.11	0.10	2.28	0.10	0.10	0.30	0.11	0.10	1.86	0.10	0.10	0.28
Other	0.09	0.08	1.90	0.09	0.09	−0.08	0.09	0.08	1.68	0.09	0.09	−0.18
Charlson index	1.66	1.55	5.62	1.58	1.58	0.28	1.64	1.53	5.81	1.56	1.56	0.36
Insulin dependence	0.31	0.22	**21.74**	0.26	0.26	0.66	0.31	0.22	**21.93**	0.26	0.26	0.75
Lipidemia	0.76	0.70	**15.61**	0.75	0.75	−0.37	0.77	0.70	**15.68**	0.75	0.75	−0.26
Cognitive impairment	0.14	0.20	**−16.47**	0.15	0.15	0.62	0.13	0.19	**−16.68**	0.14	0.14	0.76
Ocular complication	0.17	0.11	**17.33**	0.14	0.14	0.84	0.17	0.11	**17.36**	0.14	0.14	0.89
Lower Extremity complication	0.70	0.66	8.29	0.67	0.67	0.52	0.70	0.66	8.70	0.67	0.67	0.63
Renal complication	0.23	0.18	**14.54**	0.20	0.20	0.87	0.24	0.18	**15.27**	0.20	0.20	0.77
Cardiovascular complication	0.50	0.40	**20.91**	0.44	0.44	0.61	0.49	0.38	**22.55**	0.43	0.43	0.46

Note: Standardized differences greater than 10% are in bold.

Table 4. Cox proportional hazard results

	Death	Congestive heart failure	Myocardial infarction	Stroke and/or TIA
Intensive drug treatment	0.95[b] (0.93–0.97)	2.32[b] (2.27–2.38)	4.27[b] (4.05–4.52)	1.80[b] (1.70–1.89)
Adherence	0.29[b] (0.28–0.29)	0.73[b] (0.71–0.74)	0.64[b] (0.62–0.67)	0.82[b] (0.78–0.86)
Year	0.97[b] (0.96–0.97)	0.93[b] (0.93–0.94)	0.95[b] (0.94–0.96)	0.94[b] (0.93–0.96)
Age	1.05[b] (1.05–1.05)	1.05[b] (1.05–1.05)	1.03[b] (1.03–1.04)	1.03[b] (1.03–1.04)
Male	1.16[b] (1.14–1.19)	1.02 (0.99–1.04)	1.22[b] (1.17–1.28)	0.94[a] (0.89–0.99)
Black	0.86[b] (0.83–0.88)	1.01 (0.98–1.05)	0.82[b] (0.76–0.88)	1.19[b] (1.11–1.29)
Other	0.80[b] (0.77–0.83)	0.95[a] (0.91–0.99)	0.74[b] (0.68–0.81)	0.86[b] (0.78–0.96)
Charlson index	1.25[b] (1.25–1.25)	1.21[b] (1.21–1.22)	1.17[b] (1.16–1.18)	1.30[b] (1.29–1.30)
Insulin dependence	1.52[b] (1.49–1.55)	1.08[b] (1.05–1.11)	1.29[b] (1.23–1.35)	1.04 (0.99–1.11)
Lipidemia	0.89[b] (0.87–0.90)	0.79[b] (0.77–0.81)	0.83[b] (0.79–0.88)	0.97 (0.92–1.03)
Cognitive impairment	1.45[b] (1.42–1.49)	1.14[b] (1.11–1.18)	0.92[b] (0.87–0.98)	1.15[b] (1.08–1.23)
Ocular complication	1.23[b] (1.20–1.26)	1.11[b] (1.08–1.15)	1.26[b] (1.19–1.33)	1.17[b] (1.09–1.26)
Lower extremity complication	1.24[b] (1.21–1.27)	1.19[b] (1.17–1.22)	1.01 (0.96–1.06)	1.05 (0.99–1.12)
Renal complication	1.66[b] (1.62–1.69)	1.39[b] (1.36–1.43)	1.37[b] (1.30–1.44)	1.04 (0.98–1.11)
Cardiovascular complication	1.12[b] (1.10–1.15)	1.18[b] (1.15–1.20)	1.18[b] (1.12–1.23)	1.38[b] (1.31–1.46)
N	716,852	487,443	678,210	683,076
% failed	7.31	6.73	1.23	0.88

Numbers presented are hazard ratios with 95% confidence intervals in parentheses.
[a]$\alpha \leq 0.05$. [b]$\alpha < 0.01$.

In contrast, among those who survived until they were diagnosed with a study condition, being in the treatment group was associated with increased risk of being diagnosed with CHF (HR 2.32; 95% CI 2.27–2.38), and being hospitalized for a MI (HR 4.27; 95% CI 4.05–4.52), and stroke or TIA (HR 1.80; 95% CI 1.70–1.89) during the follow-up period. Conversely adherence to screening guidelines was associated with a reduced risk for all 3 study complications: for CHF (HR 0.73; 95% CI 0.71–0.74), MI (HR 0.64; 95% CI 0.62–0.67), and stroke or TIA (HR 0.82; 95% CI 0.78–0.86) hospitalizations. Increased age was associated with a fairly uniform increase in risk of 3–5% per year of age for all 3 study cardiovascular/cerebrovascular outcomes, whereas each successive year decreasing this risk by 5–7%. Men were more likely to be hospitalized for a MI (HR 1.22; 95% CI 1.17–1.28) but less likely to be hospitalized for a stroke or TIA (HR 0.94; 95% CI 0.89–0.99) than women were. Blacks were at increased risk for hospitalization for stroke or TIA (HR 1.19; 95% CI 1.11–1.29) but at a decreased risk for hospitalization for a MI (HR 0.81; 95% CI 0.75–0.87). The Charlson index was positively associated with health risks for all 3 study conditions.

DISCUSSION

Although IDT for T2D and hypertension was not associated with a lower risk for severe cardio- and cerebrovascular outcomes among Medicare beneficiaries diagnosed with both T2D and hypertension, it was associated with a lower mortality risk. Adherence to T2D screening guidelines was associated with improvements in all 4 outcome measures. A previous study documented no relationship between adherence to medication guidelines and use of multiple medications in patients with T2D.[26] Our results on adherence to screening guidelines are generally consistent with previous findings using a different and much smaller sample than the one used here.[27]

There are 2 possible explanations for these findings. The first is that IDT for diabetes mellitus and hypertension actually reduced the risk of death. Our measure of mortality was for all causes, not just for CHF, MI, and stroke or TIA. Reductions in the risk of sudden death in turn may have allowed the person to reach a hospital for life-saving therapy, including for MI and stroke or TIA rather than dying before reaching a hospital. Since the person was admitted to the hospital, there were additional hospital claims for study outcomes. Even though we controlled for important comorbidities and general adherence to diabetes screening, the possibility of survivorship bias remains. The additional survivors were generally at a higher risk for added inpatient and ambulatory care, including for this study's morbidity outcomes.

Second, there is a possibility that the negative relationship between IDT and mortality risk is spurious. For example, there may have been some unmeasured aspect of quantity and quality of care that was systematically related to IDT that accounts for our observed results. Furthermore, even though we matched on health status at the beginning of each person-year, there may be unmeasured differences in health at the baseline of each 1-year period among survivors that were not recorded in our data.

This study has several important strengths. The 5% sample of US elderly persons diagnosed with diabetes mellitus and

hypertension is large, nationally representative, and longitudinal. Availability of Part D claims allowed us to measure receipt of prescription drugs from administrative data rather than from patient self-report. The large sample permitted PSM of the IDT and control for many demographic and clinical covariates—the Charlson index and on frequently occurring complications of diabetes, and to achieve balance between the 2 groups. Previous studies of this topic have been based on much smaller and localized samples.[28,29] The index of adherence to screening guidelines reflected use of common laboratory tests as regular receipt of office visits by both generalist physicians and physicians specialized in the care of persons diagnosed with diabetes. The American Diabetes Association guidelines encompass recommendations for control of hypertension and other chronic conditions. By contrast, many other guidelines do not account for care of persons with multiple chronic conditions.[30]

We also acknowledge some study limitations: the omission of the behavioral aspects of T2D management such as smoking, physical exercise, and diet, which were not observable in Medicare claims and enrollment data; the exclusion of Medicare Advantage enrollees; and use of administrative rather than data from clinical records, although the validity of Medicare data use for the conduction of clinical research has been demonstrated.[31–33] Finally, this study does not account for the role of aortic stiffness[34,35] as the predictive power of this cardiovascular risk factor in older populations is known to be low, especially when other cardiovascular risk factors have been controlled for.[36]

CONCLUSION

This study revealed that IDT for T2D and hypertension is associated with a reduced risk of death in a nationally representative sample of elderly persons dually diagnosed with diabetes mellitus and hypertension. By contrast, risks of serious adverse cardiovascular and cerebrovascular outcomes were higher in the IDT group than in controls. Our finding on all-cause death following prescription of multiple medications calls into question the view that this practice represents a health risk, at least in the context of elderly persons with diabetes mellitus and hypertension.[33]

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DISCLOSURE

The authors declared no conflict of interest.

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