The Direct Cost of Cardiovascular Disease-related Death in Patients With Type 2 Diabetes Mellitus in a Commercially Insured Population in the United States

Sharash Shetty[1], Dana Stafkey-Mailey[2], Binglin Yue[2], Anna D. Coutinho[2], Weijia Wang[1], Pamela B. Landsman-Blumberg[2], Stephen D. Sander[1], Craig I. Coleman[3]
[1]Boehringer Ingelheim Pharmaceuticals, Inc., Ridgefield, CT, USA; [2]Xcenda, LLC, Palm Harbor, FL, USA; [3]University of Connecticut, Storrs, CT, USA

BACKGROUND

- The estimated risk of cardiovascular disease (CVD)-related death among patients diagnosed with type 2 diabetes mellitus (T2DM) is 2 to 6 times higher than among persons without diabetes.[1,2]
- There is a lack of data on healthcare utilization and costs preceding CVD-related death in T2DM patients.

STUDY OBJECTIVES

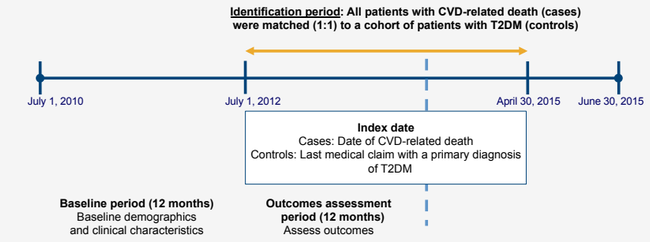
- Assess the proportion of patients who died of a CVD-related cause in the patient population with T2DM.
- Assess the magnitude of difference in all-cause healthcare resource utilization and costs between T2DM patients who did and did not die from a CVD-related cause during the 1 year preceding death.

METHODS

Data Source and Study Design

- Data Source: IMS LifeLink PharMetrics Plus™ Claims Database.
- Retrospective, matched cohort study design.

Figure 1. Retrospective, Matched Cohort Study Design



CVD – cardiovascular disease; T2DM – type 2 diabetes mellitus.

Sample/Population Selection Inclusion Criteria

- Target population: T2DM patients who died of a CVD-related cause (cases) were matched to those with no evidence of death from any cause (controls).
- Inclusion:
  - Diagnosis of T2DM during the baseline period
  - ≥18 years of age as of the index date
  - Continuous health plan enrollment during the baseline and outcomes assessment periods
- Exclusion:
  - Diagnosis of pregnancy, gestational diabetes, secondary diabetes, or type 1 diabetes mellitus any time during the baseline or outcome assessment periods
  - Missing demographic information during the baseline period (eg, age, gender, geographic region)
- Matching:
  - Cases were matched (1:1 ratio) to controls using exact matching on demographic characteristics, including age at index ±2 years, gender, geographic region, plan type, and index year.

Definitions

- T2DM status: identified during the baseline period, and defined as having:
  - ≥1 hospitalization with a diagnosis of T2DM in any diagnosis field OR
  - ≥2 medical claims at least 30 days apart within 12 months in the outpatient setting, except lab and radiology, with a diagnosis of T2DM in any diagnosis field OR
  - ≥1 pharmacy claim indicated for T2DM, including a) a non-insulin injectable, or b) an oral anti-diabetic agent, except metformin, or c) metformin pharmacy claim without a diagnosis code for pre-diabetes or polycystic ovary syndrome[3]
- CVD-related death:
  - A procedure or diagnosis code designating an end of life procedure (ie, expired at discharge, cardiopulmonary resuscitation, defibrillation, cerebral death, evidence of injection given to stimulate the heart, cardiac arrest, or cardiac complications) coded on an outpatient claim or during the same hospitalization claim and occurring during the last month before the date of last claim activity or plan disenrollment

Study Outcomes

- Healthcare resource utilization during the 12-month period prior to and including the index date:
  - Length of stay per hospitalization
  - Bed-days during the post-index period reported per patient
  - Number of all-cause and CVD-related visits by setting of care
- Healthcare costs in 2015 United States dollars (USD) assessed during the 12-month period and in quarterly increments in the year preceding and including the index date.
  - All-cause costs
  - CVD-related costs

Statistical Analysis

- Baseline characteristics: paired t-tests and McNemar's test were used to account for matching.
- Success of matching: standardized difference of <10% was indicative of acceptable balance.
- Healthcare resource use and costs: paired t-tests and McNemar's test were used to account for matching.
- All analyses were conducted using SAS® version 9.2 (SAS Institute; Cary, NC, USA).

RESULTS

Sample Characteristics

- Of 19,204 patients who died, 7,648 (39.8%) cases were matched 1:1 with 7,648 controls.
- After matching, the post-match standardized differences remained >10% for type of CVD, Charlson Comorbidity Index, and CVD risk factors: hypertension and obesity **(Table 1)**.

RESULTS (CONTINUED)

Table 1. Baseline Demographic and Clinical Characteristics

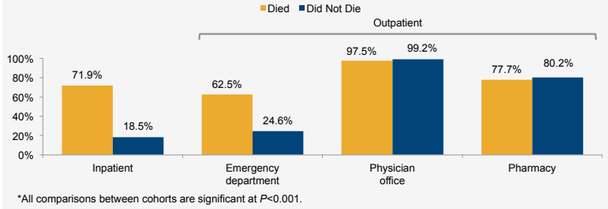
Characteristics During the Baseline Period	Died (N=7,648)		Did Not Die (N=7,648)		*Stand. Diff.*
Age as of index (in years), mean (SD)	67.2	(11.3)	67.2	(11.2)	0.36%
Male, n (%)	4,882	(63.8%)	4,882	(63.8%)	0.00%
Payer type, n (%)					
Commercial	6,614	(86.5%)	6,658	(87.1%)	13.29%
Medicaid/SCHIP	115	(1.5%)	48	(0.6%)	-
Medicare	840	(11.0%)	821	(10.7%)	-
Unknown/other	79	(1.0%)	121	(1.6%)	-
Type of CVD, n (%)					
Angina (pectoris or unstable)	613	(8.0%)	278	(3.6%)	18.78%
Arrhythmias	2,344	(30.6%)	1,144	(15.0%)	38.07%
Arterial thrombosis/embolism	81	(1.1%)	33	(0.4%)	7.30%
Atherosclerosis and other ischemic heart disease	3,321	(43.4%)	1,795	(23.5%)	43.27%
Cardiac arrest	69	(0.9%)	5	(0.1%)	12.08%
Cardiomyopathy	926	(12.1%)	232	(3.0%)	34.82%
Conduction disorders	554	(7.2%)	255	(3.3%)	17.53%
Endocarditis, pericarditis, myocarditis	1,362	(17.8%)	608	(7.9%)	29.76%
Heart failure	2,092	(27.4%)	588	(7.7%)	53.55%
Myocardial infarction	1,179	(15.4%)	398	(5.2%)	34.07%
Other heart disease	783	(10.2%)	300	(3.9%)	24.81%
Peripheral vascular disease	886	(11.6%)	471	(6.2%)	19.17 %
Rheumatic heart disease and fever	347	(4.5%)	138	(1.8%)	15.68%
Stroke	1,244	(16.3%)	724	(9.5%)	20.41%
Charlson Comorbidity Index, mean (SD)	1.99	(2.18)	0.99	(1.54)	53.08%
Presence of CVD risk factors, n (%)					
Dyslipidemia	5,619	(73.5%)	5,677	(74.2%)	1.73%
Hypertension	5,844	(76.4%)	5,175	(67.7%)	19.58%
Obesity	809	(10.6%)	523	(6.8%)	13.29%

CVD – cardiovascular disease; SCHIP – State Children's Health Insurance Program; SD – standard deviation.

Study Outcomes

Figure 2. Proportion of Patients With ≥1 Visit or Pharmacy Claim During the 12-month Period Prior to and Including the Index Date, by Type*

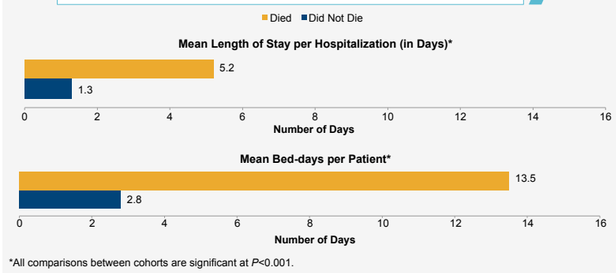
A significantly greater proportion of patients who died used inpatient and emergency department services compared to those who did not die. Conversely, physician office, and pharmacy services were used by somewhat higher percentages of patients who did not die.



*All comparisons between cohorts are significant at $P<0.001$.

Figure 3. Mean Length of Stay and Bed-days During the 12-month Period Prior to and Including the Index Date

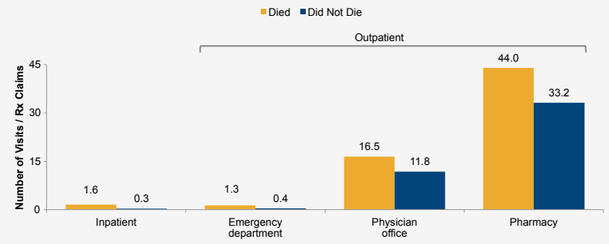
Among patients with a hospitalization, the average length of stay was significantly longer, and the average number of annual bed-days was significantly higher for patients who died compared to those who did not die.



*All comparisons between cohorts are significant at $P<0.001$.

Figure 4. Average Number of Visits or Unique Prescription Claims During the 12-month Period Prior to and Including the Index Date, by Type*

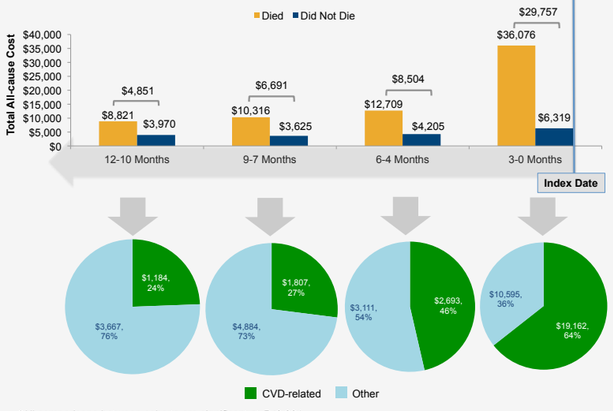
Patients who died had significantly more inpatient, emergency department, and physician office visits, as well as pharmacy claims, on average, compared to those who did not die.



*All comparisons between cohorts are significant at $P<0.001$.

Figure 5. Quarterly All-cause Total Costs (in 2015 USD), Prior to and Including the Index Date*

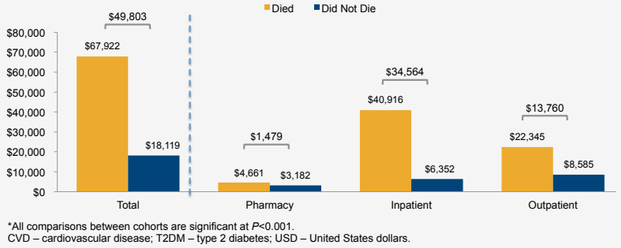
All-cause costs for patients who died were twice as high as those for patients who did not die 10 to 12 months prior to death and nearly 6 times higher within the 3 months immediately preceding and including death.



*All comparisons between cohorts are significant at $P<0.001$.
CVD – cardiovascular disease.

Figure 6. All-cause Total Costs (in 2015 USD) During the 12-month Period Prior to and Including the Index Date, Total and by Service Type*

Inpatient visits contributed to the largest increase in costs between T2DM patients who died and those who did not die, which was 6.4 times that of patients who did not die.



*All comparisons between cohorts are significant at $P<0.001$.
CVD – cardiovascular disease; T2DM – type 2 diabetes; USD – United States dollars.

LIMITATIONS

- Deceased status could not be verified, as the date of death was not available in the database due to privacy regulations. Based on the proxy definitions for CVD-related death, some surviving patients may have been incorrectly assigned to the cohort who died.
- Comorbidities and conditions were identified using diagnosis codes on medical claims; to the extent that these were miscoded or under-coded, there may be a possibility of measurement error.
- Since the matching process did not eliminate all differences in baseline characteristics between the matched cohorts, especially the difference in overall disease burden, residual confounding, rather than the cohort classification variable (CVD-related death), may have contributed to the differences observed in healthcare resource utilization and cost outcomes.
- Finally, as the costs were derived primarily from commercial managed care claims data, the findings of this study may not be generalizable to other populations.

CONCLUSION

- **The direct cost of patients with T2DM dying from a CVD-related cause is significantly higher in the year leading up to their death compared to T2DM patients who did not die.**
- **During the year preceding death, direct costs are highest during the 3 months immediately preceding and including death.**
- **Hospitalization was the largest driver of cost difference for T2DM patients with CVD-related death.**

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