

Heterogeneity of healthcare costs among Medicare Advantage patients with type 1 diabetes

Gosia S. Clore¹, S. Lane Slabaugh¹,
Bradley H. Curtis², Haoda Fu²,
Dara P. Schuster²

1. Comprehensive Health Insights, Humana, Louisville, KY, USA; 2. Eli Lilly and Company, Indianapolis, IN, USA

Background

Type 1 diabetes (T1D) is a disease that most often has its onset during adolescence, but affects patients for the remainder of their lives. Not only are patients dependent on insulin for survival, but patients are also susceptible to developing comorbidities and complications such as kidney dysfunction, neuropathy, retinopathy and potentially blindness, and cardiovascular disease. Because of the complexity of managing the disease and the associated comorbidities, T1D create a financial burden for patients, caregivers, and the healthcare system. Understanding drivers of costs among specific patient sub-groups is important for targeting support initiatives.

Objective

To describe the cost drivers (patient characteristics and comorbid conditions) among patients across the continuum of healthcare costs.

Methods

Study Design: A retrospective claims analysis of Medicare Advantage with prescription drug insurance (MAPD) patients.
Data Source: Health insurance claims (both pharmacy and medical) from Humana, a large managed care organization in the United States.

Study Timeframe:

- **Baseline period:** July 1, 2010 through June 30, 2011
- **Follow-up period:** July 1, 2011 through June 30, 2012
- **Full study period:** July 1, 2010 to June 30, 2012

Inclusion Criteria:

- Age ≥19 and <90 as of July 1, 2010
- Continuous enrollment in an MAPD plan for the full study period unless terminated by death
- Diagnosis of T1D, as indicated by any of the following:
 - ≥1 medical claim with a diagnosis of T1D (ICD-9-CM codes 250.x1 or 250.x3), no medical claims with a diagnosis of T2D (ICD-9-CM code 250.x0 or 250.x2), ≥1 pharmacy claim for insulin, and no gaps of 6 or more months in pharmacy claims for insulin .
 - Claims for both T1D and T2D (ratio of T1DM:T2DM claims ≥0.5), no pharmacy claims for oral antidiabetic medications, and no gaps of 6 or more months in pharmacy claims for insulin.
 - ≥1 pharmacy claim for urine acetone test strips

Results

Table 1. Baseline Demographics

N = 877			
Age, years	mean (s.d.)	65.2	11.6
Male Gender	n (%)	418	47.7%
Race/ethnicity			
White	n (%)	705	80.4%
Black	n (%)	132	15.1%
Hispanic	n (%)	21	2.4%
Other/unknown	n (%)	19	2.2%
Population Density			
Urban	n (%)	622	70.9%
Suburban	n (%)	164	18.7%
Rural	n (%)	80	9.1%
Unknown	n (%)	11	1.3%

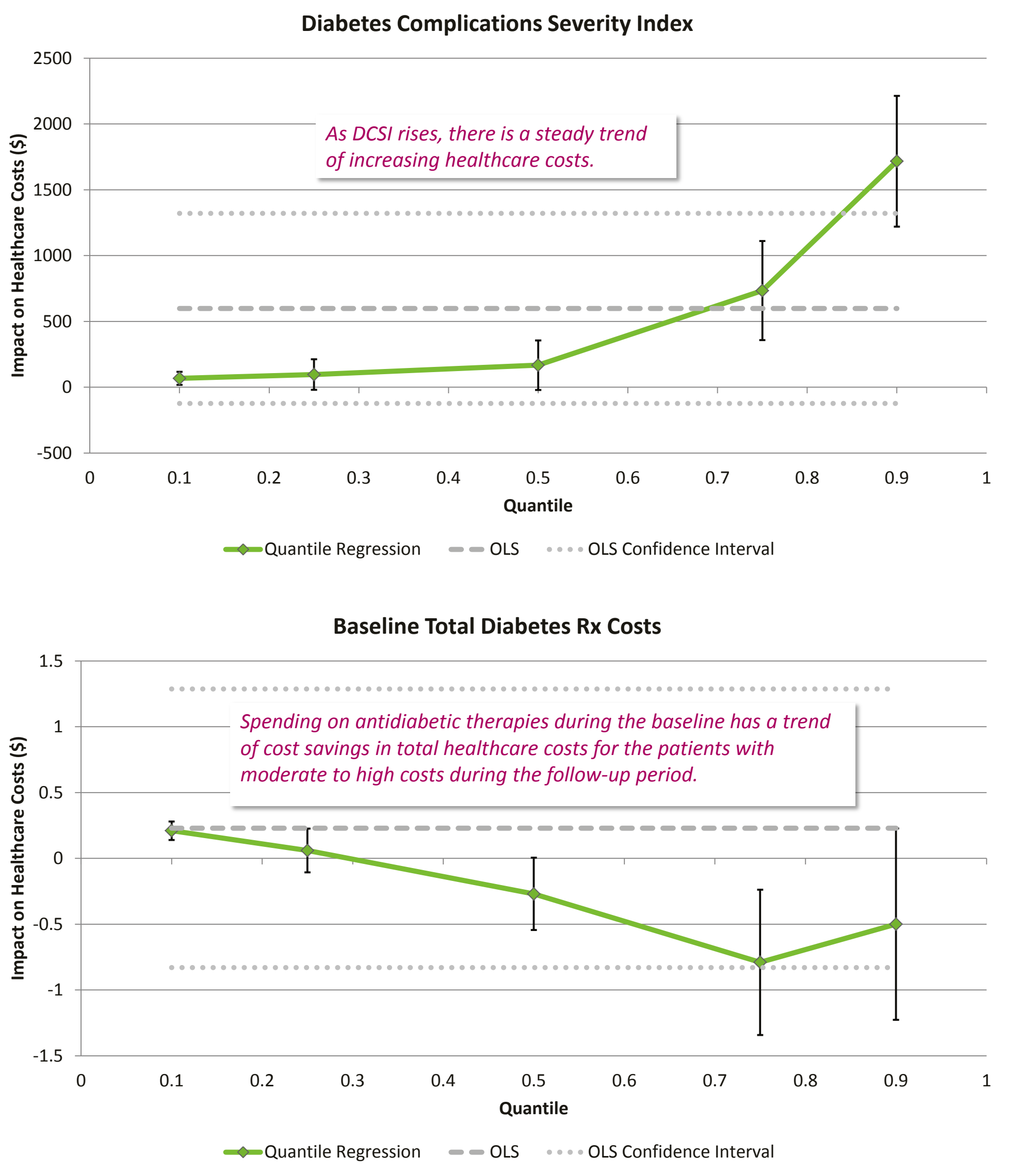
- The mean age of the T1D population among MAPD patients was lower than that of patients with type 2 diabetes (65.2 years vs. 70.6 years, respectively; T2D results to be presented elsewhere).
- The large majority of the study population were white (80.4%), and reside primarily in urban or suburban areas (70.9% and 18.7%, respectively).

Table 3. Baseline Healthcare Costs

	Mean (s.d.)	Median	Range	Inter-Quartile Range
Total Healthcare Costs	\$12,298.67 (±\$16,172.6)	\$7,795.25	\$568.66- \$222,194.24	\$4,931.26- \$13,571.44
Medical Costs	\$7,406.02 (±\$14,735.3)	\$3,228.50	\$0.00- \$208,612.35	\$1,427.29- \$7,656.82
Pharmacy Costs	\$4,892.65 (±4,208.4)	\$3,844.55	\$157.77- \$47,648.56	\$2,606.21- \$5,672.85
Pharmacy Costs Diabetes Drugs Only	\$1,895.27 (±1,370.9)	\$1,623.85	\$0.00- \$11,578.28	\$1,000.83- \$2,443.60
Pharmacy Costs Diabetes Supplies Only	\$655.31 (±837.1)	\$357.41	\$0.00- \$7,642.13	\$ 83.35- \$951.71

- Healthcare costs during the baseline period are representative of the extreme skewness of healthcare costs. Mean total healthcare costs were \$12,299, while the maximum observed total healthcare costs was >\$200,000.
- Medical costs make up the large majority of total healthcare costs.
- On average, diabetes drug costs made up 38.7% of total pharmacy costs.

Figure 1. Example Quantile Regression Plots



Methods Continued

Baseline characteristics measured included:

- Demographics
- Over 50 diabetes-related variables were described for the study population during the baseline period. These variables included:
 - Demographic characteristics
 - Diabetes complications severity index (DCSI) [1]
 - Sum of 7 diabetes complications graded by severity as 0, 1, or 2
 - Scores range from 0-13
 - Comorbid conditions
 - Healthcare resource utilization
 - Healthcare costs (all-cause and diabetes-related)
 - Total Costs
 - Medical Costs
 - Pharmacy Costs
 - Antidiabetic pharmacotherapy patterns
 - Diabetes-related laboratory values
 - Provider specialty for diabetes care (as determined using both pharmacy and medical claims)

Quantile Regression

- Quantile regression (QR) is an econometric regression model in which a conditional quantile (or percentile) of the outcome variable is expressed as a linear function of subject characteristics.
- QR was used to test for associations between the dependent variable (healthcare costs) and the independent variables. Results are compared the ordinary least squares (OLS) approach.
- Rather than assessing how the center of a conditional distribution varies with changes in subject characteristics, one can examine how any percentile of the conditional distribution is affected by changes in subject characteristics.
- The coefficients are interpreted as the change in the given percentile of the conditional distribution associated with a one-unit change in the given characteristic.
- Gradient boosting tree was used to determine the variables to be included in the final quantile regression model.

Table 2. Baseline Clinical Characteristics

N = 877			
DCSI Score	Mean (s.d.)	3.32	2.49
	Median (IQ Range)	3	1-5
Number of emergency department visits	Mean (s.d.)	0.56	1.22
Number of inpatient hospitalizations	Mean (s.d.)	1.55	5.71
Number of outpatient visits	Mean (s.d.)	28.82	29.36
Antidiabetic Treatment Categories			
Insulin only	n (%)	811	92.5%
Oral antidiabetic plus insulin	n (%)	64	7.3%
Non-insulin injectable antidiabetic plus insulin	n (%)	<10	<1.0%
Mail-order pharmacy use	n (%)	433	49.4%
Number of claims for glucose test strips	Mean (s.d.)	1.51	2.13
Number of emergent hypoglycemic events*	Mean (s.d.)	0.32	2.21
Number of non-emergent hypoglycemic events*	Mean (s.d.)	0.48	2.97
Comorbidities			
Depression	n (%)	118	13.5%
Retinopathy	n (%)	352	40.1%
Nephropathy	n (%)	380	43.3%
Neuropathy	n (%)	470	53.6%
Cardiovascular disease	n (%)	402	45.8%
Major adverse cardiac events (MACE) plus including:			
Unstable angina pectoris	n (%)	20	2.3%
NSTEMI or STEMI	n (%)	15	1.7%
Stroke	n (%)	93	10.6%
Heart failure	n (%)	114	13.0%
Peripheral artery disease	n (%)	243	27.7%
Atherosclerosis	n (%)	111	12.7%
Aortic aneurysm	n (%)	<10	<1.0%
Osteoporosis	n (%)	90	10.3%
Kidney Disease			
Stage 1 (eGFR 90+)	n (%)	148	16.9%
Stage 2 (eGFR 60-89)	n (%)	409	46.6%
Stage 3 (eGFR 30-59)	n (%)	282	32.2%
Stage 4 (eGFR 15-29)	n (%)	32	3.6%
Stage 5 (eGFR <15)	n (%)	<10	<1.0%
HbA1c values			
Number of HbA1c values during baseline period	Mean (s.d.)	2.47	1.36
Categorical HbA1c values:			
>9.0%	n (%)	186	21.2%
>8.0% and ≤9.0%	n (%)	152	17.3%
>7.0% and ≤8.0%	n (%)	273	31.1%
≤7.0%	n (%)	266	30.3%
Primary Healthcare Professional			
Endocrinologist	n (%)	81	9.2%
Nephrologist	n (%)	42	4.8%
Primary Care/Other	n (%)	754	86.0%

*Among patients with at least one event
DCSI=Diabetes Complications Severity Index; NSTEMI=non-ST segment elevation myocardial infarction; STEMI=ST segment elevation myocardial infarction; eGFR=estimated glomerular filtration rate [2]; HbA1c=hemoglobin A1c or glycated hemoglobin

- The diabetes population studied has an average DCSI score of 3.32.
- 7.5% of the study population used another antidiabetic therapy other than insulin.
- The most common comorbidities included neuropathy (53.6%), Stage 2 kidney disease based on eGFR (46.6%), cardiovascular disease (45.8%), nephropathy (43.3%), retinopathy (40.1%), and peripheral artery disease (27.7%).
- Primary care physicians were the healthcare professionals most frequently responsible for the diabetes-related care of the study population.

- The QR charts illustrate how the effects of the patient characteristics vary over cost quantiles, and how the magnitude of the effects at various quantiles differ considerably from the OLS coefficient.
- Smaller sample sizes and wider variance in costs results in wider confidence intervals in the higher cost quantiles.

Conclusions

- As is true for the general population, patients with T1D have a wide range of healthcare costs with a distribution which is highly skewed to the right.
- Many patient characteristics that showed little association with healthcare costs in the lower cost quantiles have large impacts on total costs in the higher cost quantiles.
- Quantile regression provides a more robust depiction of the impact of model covariates on cost outcomes than typical ordinary least squares regression.
- This novel approach to examination of the influence of patient characteristics and comorbidities on healthcare costs provides a valuable tool for identifying potential targets for disease intervention programs.

Limitations

- Limitations common to studies using administrative claims data apply to this study. These include lack of certain information in the database (e.g., lab results, weight, and health behavior information) and error in claims coding.
- All patients included in the study had an HbA1c laboratory value in both the baseline and follow-up periods. This may introduce a healthy patient bias, as the regular laboratory values indicates that these patients are more closely monitored by their physicians than patients without these values.

References

1. Chang H-Y, Weiner JP, Richards TM, Bleich SN, Segal JB. Validating the adapted Diabetes Complications Severity Index in claims data. The American Journal Of Managed Care. 2012;18(11):721-726.
2. Levey AS, Greene T, Kusek JW, et. al. A simplified equation to predict glomerular filtration rate from serum creatinine. J Am Soc Nephrol. 11:A0828, 2000 (abstr).