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Use and Out-of-Pocket Costs of Insulin for Type 2 Diabetes Mellitus from 2000 to 2010

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TO THE EDITOR

Insulin analogs are molecularly altered forms of insulin. Compared with human synthetic and animal insulin for type 2 diabetes, short-acting insulin analogs may offer flexible dosing and convenience, long-acting insulin analogs less nocturnal hypoglycemia,[1] but both at 2–4 times the cost.[2] As insulin analogs have become increasingly popular,[3, 4] we examined trends in insulin utilization, out-of-pocket expenditures, and concurrent trends in severe hypoglycemic events among privately insured U.S. adults with type 2 diabetes, from 2000 through 2010.

METHODS

We conducted a retrospective analysis of data from Optum Labs Data Warehouse, an administrative claims database of privately insured enrollees from throughout the U.S., but with more representation from the South and Midwest. Because this study involved analysis of pre-existing, de-identified data, it was exempt from Institutional Review Board approval. Our sample included adults aged ≥18 years with type 2 diabetes mellitus with at least 2 years of continuous enrollment between January 2000 and September 2010. We defined diabetes according to Health Plan Employer Data and Information Set criteria and excluded patients with claims for type 1 diabetes in the absence of oral antihyperglycemic medications. First, we calculated the proportion of patients with type 2 diabetes who used

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Author Contributions: Dr. Shah had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Lipska, Shah, Ross, Yudkin.
Acquisition of data: Shah.
Analysis and interpretation of data: Lipska, Ross, Van Houten, Shah.
Drafting of the manuscript: Lipska.
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any insulin in each year and characterized insulin users through descriptive analyses. Second, we calculated the proportion of patients who obtained each specific insulin type. We used the Cochran-Armitage test to assess for trends in insulin use. Third, we calculated median out-of-pocket costs of insulin associated with each insulin prescription per year (adjusted to 2010 U.S. dollars[5]). We compared median out-of-pocket costs across years using quantile regression. Finally, among insulin users, we examined age-sex adjusted rates of severe hypoglycemic events, defined as hospitalization or emergency department visit with a primary discharge diagnosis of hypoglycemia.[6] For all analyses two-sided p-value <0.05 was considered significant. All analyses were performed using SAS® statistical software (version 9.2; SAS Institute Inc., Cary, North Carolina).

RESULTS

Between 2000 and 2010, 123,486 unique patients filled at least 1 prescription for insulin, comprising 9.7% (95% CI, 9.5–9.8%) of adults with type 2 diabetes in 2000 and 15.1% (95% CI, 15.0–15.3%) in 2010 (p=0.001). Characteristics of the study sample are presented in the Table. Among adults who used insulin, 96.4% (95% CI, 96.0–96.8%) filled prescriptions for human synthetic insulin in 2000 but only 14.8% (95% CI, 14.5–15.2%) did so in 2010 (p<0.0001). In contrast, 18.9% (95% CI, 18.2–19.7%) filled prescriptions for insulin analogs in 2000 but 91.5% (95% CI, 91.2–91.8%) did so in 2010 (p<0.0001). Use of animal insulin was <1% in all years. Median out of pocket costs per prescription for all insulins increased from $19 (IQR, $14–23) in 2000 to $36 (IQR, $20–53) in 2010 (p<0.0001). These trends were accompanied by a small decline in the rate of severe hypoglycemic events among insulin users that was not statistically significant (21.1 and 17.7 events per 1,000 person-years in 2000 and 2010, respectively, p=0.054).

DISCUSSION

In our study of privately insured adults in the U.S., use of insulin among patients with type 2 diabetes mellitus increased by approximately 50% -- from 10% in 2000 to 15% in 2010 – which occurred in the context of widespread adoption of insulin analogs. Out-of-pocket expenditures increased significantly by 89%. Concurrently, severe hypoglycemic events declined slightly but this was not statistically significant.

Our study has some limitations. First, we examined insulin use only among privately insured patients; public healthcare systems with strong formularies may utilize insulin analogs to a lesser extent. Second, we had no information on total expenditures on insulin and may have underestimated the total cost to the healthcare system. Additionally, we could not account for the use or cost of insulin delivery devices (except for prefilled pens). Finally, we could not identify hypoglycemia that did not require medical assistance. Although we found a non-significant decline in severe hypoglycemia, our analyses may be underpowered and we cannot exclude changes in less severe hypoglycemic events.

In conclusion, we found a dramatic increase in the use of insulin analogs among privately insured patients with type 2 diabetes mellitus. The value of the nearly universal transition to this more expensive type of insulin is unclear.

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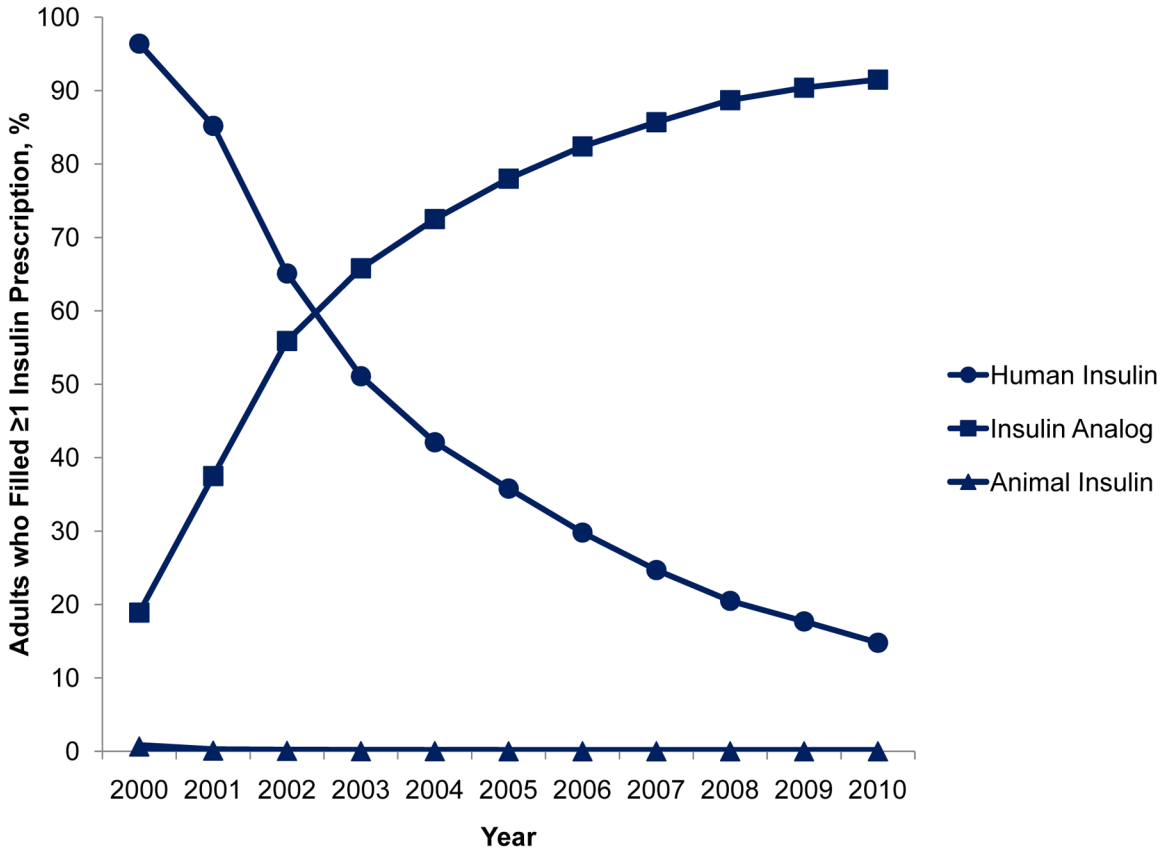
References

1. Horvath K, Jeitler K, Berghold A, Ebrahim SH, Gratzer TW, Plank J, Kaiser T, Pieber TR, Siebenhofer A. Long-acting insulin analogues versus nph insulin (human isophane insulin) for type 2 diabetes mellitus. Cochrane database of systematic reviews (Online). 2007:CD005613.
2. Gale EA. Newer insulins in type 2 diabetes. BMJ (Clinical research ed). 2012; 345:e4611.
3. Gill GV, Yudkin JS, Keen H, Beran D. The insulin dilemma in resource-limited countries. A way forward? Diabetologia. 2011; 54:19–24. [PubMed: 20835860]
4. Holden SE, Poole CD, Morgan CL, Currie CJ. Evaluation of the incremental cost to the national health service of prescribing analogue insulin. BMJ open. 2011; 1:e000258.
5. Consumer price indexes for major expenditure classes 1965–2009. 2012
6. 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. [PubMed: 18380903]



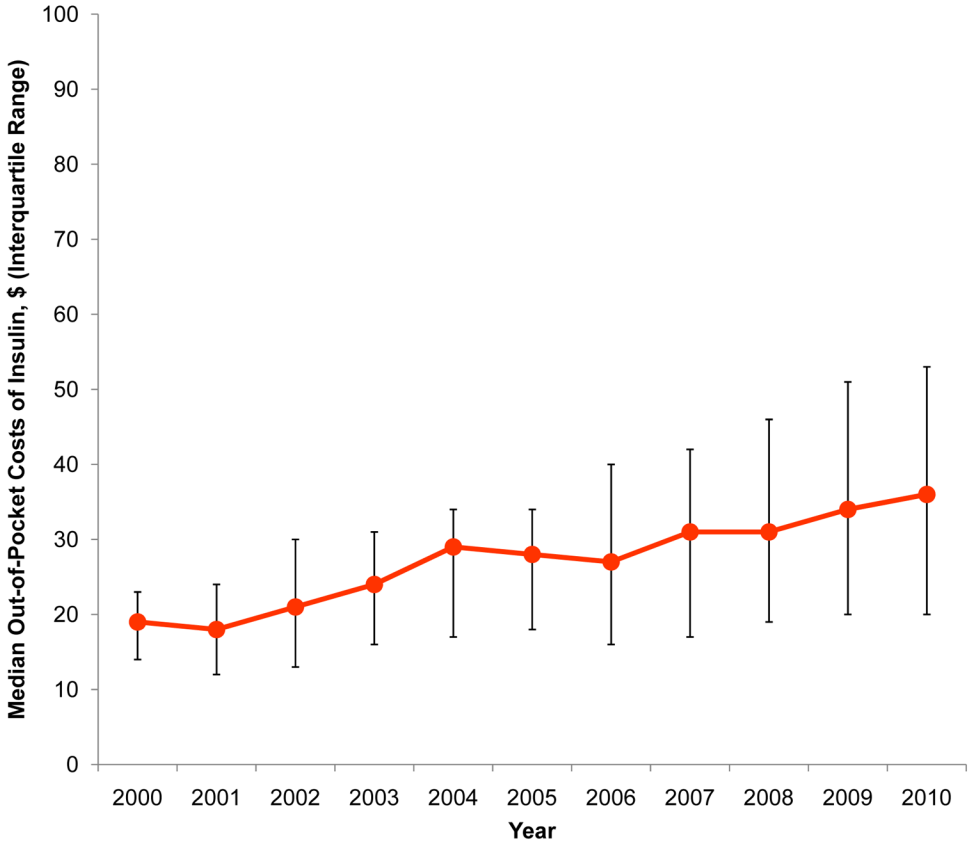


Figure.

Utilization and median out-of-pocket expenditures on human, animal, and analog insulin among type 2 diabetes patients who filled at least 1 prescription for insulin, 2000–2010.

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Table

Characteristics of patients with type 2 diabetes mellitus who were dispensed insulin, 2000–2010.

	2000–2001	2002–2003	2004–2005	2006–2007	2008–2010
Number of Patients	**21,475**	**35,457**	**48,625**	**58,370**	**63,962**
Demographics					
Age, years mean (SD)	64.4 (11.7)	63.2 (12.1)	62.8 (12.4)	61.8 (12.5)	61.2 (12.4)
Sex, % female	48.2	47.5	47.0	45.9	45.1
Race, %					
Asian	1.1	1.5	1.7	1.7	1.9
Black/African American	8.2	10.1	10.4	9.9	9.6
Hispanic	4.6	7.0	8.0	8.6	9.1
White/Caucasian	48.3	61.3	63.5	62.0	61.4
Missing/Other	37.7	20.1	16.4	17.8	18.0
Geographic Region, %					
Northeast	5.7	7.2	8.0	8.1	8.3
Midwest	38.6	34.5	32.2	29.5	27.7
South	47.8	49.0	49.4	50.8	52.3
West	7.5	9.0	10.2	11.4	11.5
Missing/Other	0.3	0.3	0.2	0.2	0.2
Comorbidities, %					
Cardiovascular Disease	26.8	28.4	28.7	28.8	28.0
Chronic Lung Disease	11.3	12.1	12.6	13.0	13.0
Chronic Kidney Disease	8.7	10.7	12.4	12.9	13.7
Cancer	6.8	7.4	8.1	8.7	9.5
Depression	9.5	10.4	10.2	10.7	11.2
Hypertension	57.0	63.2	68.3	72.3	76.2
Hyperlipidemia	48.3	58.5	66.48	71.7	75.1
Type of Insulin,* % (95% CI)					
Human Insulin	88.2 (87.8, 88.7)	59.4 (58.9, 59.9)	41.0 (40.6, 41.5)	29.4 (29.0, 29.8)	21.5 (21.2, 21.8)
Insulin Analog	35.6 (35.0, 36.3)	64.8 (64.3, 65.3)	77.1 (76.7, 77.5)	85.1 (84.8, 85.4)	91.0 (90.8, 91.3)
Animal Insulin	0.39 (0.30, 0.47)	0.05 (0.02, 0.07)	0.02 (0.01, 0.03)	0.00 (0.00, 0.01)	0.00 (0.00, 0.00)

	2000–2001	2002–2003	2004–2005	2006–2007	2008–2010
Type of Insulin Agent, % (95% CI)					
NPH	81.9 (81.4, 82.5)	52.8 (52.2, 53.3)	34.5 (34.1, 35.0)	23.1 (22.8, 23.5)	16.2 (16.0, 16.5)
Regular	58.5 (57.9, 59.2)	40.0 (39.5, 40.5)	28.6 (28.2, 29.0)	21.2 (20.9, 21.6)	15.5 (15.3, 15.8)
Lente	2.1 (1.9, 2.3)	1.1 (1.0, 1.2)	0.57 (0.50, 0.63)	0.11 (0.09, 0.14)	0.0 (0.0, 0.0)
Ultralente	2.7 (2.5, 2.9)	1.1 (1.0, 1.3)	0.48 (0.41, 0.54)	0.07 (0.05, 0.09)	0.0 (0.0, 0.0)
Glargine	11.3 (10.8, 11.7)	44.1 (43.6, 44.6)	58.4 (58.0, 58.9)	63.2 (62.8, 63.6)	64.3 (63.9, 64.6)
Detemir	0.00 (0.00, 0.00)	0.00 (0.00, 0.00)	0.00 (0.00, 0.00)	7.3 (7.1, 7.5)	16.4 (16.1, 16.7)
Aspart	0.36 (0.28, 0.44)	8.6 (8.3, 8.9)	21.4 (21.0, 21.8)	28.4 (28.0, 28.7)	32.4 (32.1, 32.8)
Lispro	29.5 (28.9, 30.1)	34.3 (33.8, 34.8)	27.8 (27.4, 28.2)	21.0 (20.7, 21.3)	20.1 (19.8, 20.4)
Glulisine	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.00 (0.0, 0.0)	1.7 (1.6, 1.8)	2.5 (2.3, 2.6)

* Human insulins include: neutral protamine Hagedorn (NPH), regular, insulin zinc human (lente), insulin zinc human extended (ultralente); insulin analogs include: aspart, detemir, glargine, glulisine, lispro; and animal insulins include: insulin isophane beef-pork, insulin isophane pork pure, insulin regular beef-pork, insulin zinc beef-pork, insulin zinc pork-purified.