

methodology.⁵ Combining hospital and police data may allow for a more complete picture of violence.

Limitations of the study include that findings are generated from a single city. Furthermore, this study focused on violence occurring in public places only and does not provide information on reporting by injury severity. Third, this study does not include comparison with minor criminal charges such as “simple assault”; although not readily used as a criminal charge for violent injuries necessitating ED treatment in this study’s jurisdictions, use of criminal charges can vary across police jurisdictions. Last, beyond the potential of misreporting by patients, only approximately 40% of violent incidents contained enough information to be mapped. Nonetheless, we hypothesize that patients declining to provide detailed information to nurses have specific reasons for nondisclosure⁶ and would therefore also be unlikely to provide such information to police. This suggests that the number of incidents unreported to police may be even higher than we detected.

In summary, these findings emphasize the potential of ED and police data to provide a complementary and comprehensive understanding of violent injury resulting in significant morbidity. This study provides new support for the United States on the value of cross-sectoral partnerships, the importance of ED-collected violence data, and the potential of such efforts to improve violence prevention.

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Cost-Related Insulin Underuse Among Patients With Diabetes

Insulin is lifesaving for people with diabetes and is included on the Model List of Essential Medicines formulated by the World Health Organization.¹ This means it should be available at all times at a price the individual and the community can afford.¹

However, over the past decade, insulin prices have tripled in the United States, while out-of-pocket costs per prescription doubled.^{2,3} High costs of medications can contribute to nonadherence,⁴ but the prevalence of cost-related insulin underuse is unknown.

Methods | We administered a survey to patients with type 1 or type 2 diabetes for whom insulin was prescribed within the past 6 months and who had an outpatient visit at the Yale Diabetes Center (YDC) between June and August of 2017. The YDC serves a diverse patient population from New Haven, Connecticut and surrounding counties. The survey questions were based on previously validated surveys^{5,6} and review of prior literature and refined based on cognitive interviews. The Yale University Human Investigations Committee approved the study. Written informed consent was obtained from participants.

The primary outcome was cost-related underuse in the past 12 months, defined by a positive response to any 1 of 6 questions: did you... (1) use less insulin than prescribed, (2) try to stretch out your insulin, (3) take smaller doses of insulin than prescribed, (4) stop using insulin, (5) not fill an



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Table. Characteristics of Survey Participants

Characteristic	Participants, No.	With Cost-Related Insulin Underuse, No. (%)	Odds Ratio (95% CI)
All Participants	199	51 (25.5)	
Age, y			
18-44	63	20 (31.7)	1 [Reference]
44-64	84	20 (23.8)	1.14 (0.40-3.35)
≥64	52	11 (21.2)	0.90 (0.25-3.28)
Sex			
Female	101	28 (27.7)	1 [Reference]
Male	98	23 (23.5)	1.14 (0.49-2.66)
Race/ethnicity			
White	121	26 (21.5)	1 [Reference]
Latino/Hispanic/Latin American	14	4 (28.6)	1.00 (0.17-4.86)
Black/African American	49	16 (32.7)	1.71 (0.58-5.05)
Other/did not report	15	4 (33.3)	1.66 (0.38-6.83)
Diabetes			
Type 1	83	22 (26.5)	1 [Reference]
Type 2	115	29 (25.2)	0.91 (0.33-2.55)
Did not report	1		
Type of insulin used			
Analog	181	44 (24.3)	1 [Reference]
Human	12	4 (33.3)	3.17 (0.68-13.36)
Both	6	3 (50.0)	2.79 (0.30-37.85)
Prescription drug coverage			
Medicare Part D	40	7 (17.5)	1 [Reference]
Employer-sponsored	66	21 (31.8)	1.03 (0.29-3.95)
Medicaid with/without Medicare	85	19 (22.4)	3.05 (0.80-13.01)
None/other/unknown	8	4 (50)	2.19 (0.24-19.37)
Annual Income, \$			
100 000 and greater	24	1 (4.2)	1 [Reference]
50 000-99 999	26	10 (38.5)	12.51 (1.83-255.85)
25 000-49 999	37	14 (37.8)	11.50 (1.62-239.06)
10 000-24 999	53	13 (24.5)	9.79 (1.15-220.25)
<10 000	36	7 (19.4)	6.42 (0.65-154.07)
Did not report ^a	23		
Difficulty buying diabetes medical equipment			
No	144	21 (14.6)	1 [Reference]
Yes	55	30 (56)	5.89 (2.52-14.50)

^a Missing Income values were excluded from multivariable analysis.

insulin prescription, or (6) not start insulin...because of cost? We examined the association between sociodemographic, economic, and clinical factors and cost-related underuse using multivariable logistic regression.

We then examined the association between cost-related underuse and poor glycemic control (HbA1c ≥9% obtained at time of visit or within 3 months) adjusting for sex, body mass index (BMI, calculated as weight in kilograms divided by height in meters squared), diabetes duration, and income using a separate multivariable logistic regression model. We performed all analyses using R statistical software (version 3.1.1, R Foundation).

Results | Of 354 eligible patients (184 [52.0%] women, 191 [54.0%] white, 123 [34.8%] type 1 diabetes), 199 (56.2%) completed the survey (101 [50.8%] women, 121 [60.8%] white, 83 [41.7%] type 1 diabetes). Of these patients, 51 (25.5%) reported cost-related insulin underuse. The type of prescription drug coverage was not significantly associated with cost-related underuse (Table). Patients with cost-related underuse were more likely to report lower incomes; 31 [60.8%] of these patients discussed the cost of insulin with their clinician and 15 [29.4%] changed insulin type owing to cost. Patients who reported cost-related underuse (vs those who did not) were more likely to have poor glycemic control in the multivariable analysis (22 [43.1%] vs 41 [28.1%]; odds ratio = 2.96; 95% CI, 1.14-8.16; *P* = .03). Of the 199 patients, 2 had missing HbA1c levels.

Discussion | One in 4 patients at an urban diabetes center reported cost-related insulin underuse and this was associated with poor glycemic control. These results highlight an urgent need to address affordability of insulin.

More than one-third of patients who experienced cost-related underuse did not discuss this with their clinician. These findings are consistent with a previous study, which found that 37% of patients did not speak to clinicians about cost issues.⁴ Patients with lower incomes were more likely to report cost-related underuse; nearly two-thirds of these patients also experienced difficulty affording diabetes equipment, indicating broader cost barriers to diabetes management.

This study has limitations. This single-center study may be limited in its broader generalizability. Given its cross-sectional design, a causal relationship between cost-related underuse and poor glycemic control cannot be established.

Insulin is a life-saving, essential medicine, and most patients cannot act as price-sensitive buyers. Regulators and the medical community need to intervene to ensure that insulin is affordable to patients who need it. At minimum, individual clinicians should screen all patients for cost issues to help them address these challenges.

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Invited Commentary

When High Prices Mean Needless Death

I have spent the last 5 years of my life as a journalist writing about the irrational costs and prices across the US health care system. But if there is 1 fact that should cause national embarrassment it is the high price tag we affix to living with type 1 diabetes.

The medicinal and technological advances of the last century have turned type 1 diabetes from a rapidly fatal disease into a treatable illness. But doing so takes discipline



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and care—as well as increasingly expensive technology and medicine—that is far more expensive in the United States than elsewhere.

That is because people with type 1 diabetes are both beneficiaries and pawns in the business ventures of drug makers, device manufacturers, and insurers, and sometimes these com-

panies seem willing to sacrifice a pawn or 2 for profits. Today people with type 1 diabetes are again at an increased risk of becoming ill and even dying prematurely because of the price.

Between 2007 and 2017, the average wholesale price of 4 of the most popular insulins has more than tripled in price.¹ Between 2010 and 2015, the monthly wholesale price of Humulin, the most popular insulin, rose to nearly \$1100, up from \$258 for the average patient.

In this issue of *JAMA Internal Medicine*, Herkert et al² report the results of a survey on insulin underuse that was associated with costs that was administered at the Yale Diabetes Center. Of 199 patients who completed the survey (57% response rate), 51 (25.5%) reported cost-related underuse and were 3 times more likely to have poor glycemic control.

As a journalist, I hear wrenching patient stories, such as that of a restaurant manager who died shortly after turning age 26 years and going off his mother's insurance. The price tag to treat his diabetes was \$1300 a month, which was mostly for insulin. He died of diabetic ketoacidosis 3 days before his payday. An empty insulin pen was found in his apartment.³

A student at DePauw University with type 1 diabetes was losing weight, fatigued, and doing poorly in school. It was only after a coach, alarmed, notified his parents that they discovered he had been skimping on his insulin to save money.¹

Such tragedies and tragedies in the making are explained by Herkert et al²; to save money, 25% of people are using less insulin than prescribed. What is more alarming is that a third of those did not tell their physician (or, presumably, their parents) that they were taking the risk.

As drug costs have generally increased in the United States, we know that many patients are skimping on medicines, taking less than prescribed, and cutting pills in half to make every fill last longer. This is terrible, but for many diseases, it is not catastrophic. If you use less of your asthma inhaler you will be somewhat short of breath. If you skimp a bit on sleeping medicines or even blood pressure pills, you will have a chance to self-correct. But skimping on insulin can be rapidly deadly in people whose bodies make none of their own and can result in a life-threatening metabolic disturbance.

It can also hasten disability (eg, blindness and kidney failure) and early death. Thanks to tight glucose control and more precise insulin dosing, researchers estimated in 2012 that children with diabetes born between 1965 and 1980 were living 15 years longer than those born between 1950 and 1965.⁴

Will that 15-year gain now be erased because of the price? It is important to consider that this is typically a disease that starts in childhood, meaning that people with diabetes must traverse their 20s with the illness, a decade during which their earnings are low and Americans are likely to be uninsured or underinsured.

Frederick Banting and colleagues, who discovered and isolated insulin in the early 1920s, licensed the patent for \$1, so the blame is not with them.⁵ Who then is to blame for the price inflation?

The for-profit drug and device makers who sell insulins and insulin delivery devices have not followed the example of Banting et al. They have increased the price of their products year after year because, simply, they can. They have spent millions filing lawsuits that successfully keep competitors off of the US mar-

ket. A biosimilar of Sanofi's popular insulin Lantus was approved for use in the European Union in 2014 but was initially delayed for 2 more years by a lawsuit in the United States.⁶ Now that the biosimilar product, Basaglar, has finally hit the market, its price is only minimally lower than the original brand.⁷ The same insulin pen that retails for \$140 in the United States costs less than \$15 in Germany and Canada.⁸

The US insurance system—private and public—does not cut people with chronic disease a break but instead tends to penalize them. People with type 1 diabetes are people who drew a short straw in the disease lottery. Most other developed countries have concluded that their citizens should therefore not be subject to copays or high deductibles. “If you have a chronic disease, you shouldn't be burdened by the cost,” York F. Zöllner, a professor of health economics at Hamburg University of Applied Sciences, told me in an interview for the *New York Times* before explaining the German approach, in which out-of-pocket contributions for insulin are less than \$100 per year.⁹ Until very recently, the disease foundations (JDRF and the American Diabetes Association among them), as well as many diabetes patient groups, did not protest much as the prices rose, in part likely because so many receive funding from pharmaceutical companies.

Extreme prices can lead to extreme solutions. A 29-year-old student in Missouri with diabetes whom I interviewed for my book¹⁰ told me that she would only consider doctoral programs outside of the United States. “My one goal in life has been to move to Europe so I don't have to pay these staggering prices just to survive,” she said.

But others—that 25%—will quietly skimp on their insulin, taking less than they need but more, perhaps, than they can really afford. Some of them will die.

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Association Between Cannabis Use and Risk for Diabetic Ketoacidosis in Adults With Type 1 Diabetes

Cannabis use is increasing with the shifts in legality and public perceptions in the United States.¹ Studies have reported improvement in insulin sensitivity and pancreatic beta cell function with cannabis use,^{2,3} generating widespread media attention suggesting cannabis as a potential therapeutic agent for treatment of type 2 diabetes. By contrast, we published a case series⁴ reporting recurrent diabetic ketoacidosis (DKA) with cannabis use in patients with type 1 diabetes (T1D). Because little is known about cannabis use and its contribution to DKA in T1D, we investigated the characteristics of cannabis use among adults with T1D and the association of cannabis use with DKA.

Methods | Between June 2017 and January 2018, adults aged 18 years or older with T1D attending the Barbara Davis Center for Diabetes, the largest T1D treatment center in Colorado, where cannabis is legal for medical and recreational use, were invited to complete an in-person questionnaire on their cannabis use. Patients with diabetes other than T1D, pregnancy, and repeat follow-up visits within the study duration were excluded. A questionnaire was used to collect demographic characteristics, diabetes history and complications, severe hypoglycemia requiring assistance, and cannabis use information. Point-of-care hemoglobin A_{1c} level (HbA_{1c}; DCA Vantage Analyzer) was measured during the clinic visit. Scores on the Cannabis Use Disorder Identification Test-Revised⁵ were used to define hazardous cannabis use (score ≥8 and <12) and possible cannabis use disorder (score ≥12). The Colorado Multiple Institutional Review Board (Aurora, Colorado) approved this study, and all participants provided written informed consent.

The primary outcome was DKA hospitalization during the preceding 12 months. All self-reported DKA hospitalizations were confirmed by medical record review. Comparison of categorical variables was conducted with 2-tailed χ^2 tests, and 2-sample *t* tests were used to test normally distributed continuous variables. A logistic regression model was built to calculate the odds of DKA hospitalization by cannabis use. Clinical evidence-based risk factors for DKA, such as age, sex, diabetes duration, income, educational level, HbA_{1c} level, and insurance (derived from income), were modeled, and a stepwise selection method was used to confirm the final model. Model fit was assessed by Akaike information criterion. Sensitivity analyses were performed using propensity score matching of cannabis users and nonusers, adjusting for age, sex, ethnicity, tobacco and alcohol use, educational level, income,