THE EFFECT OF INSULIN PUMP THERAPY ON HBA1C AMONG THOSE WITH TYPE 1 DIABETES

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INTRODUCTION

- Type 1 diabetes (T1D) is a chronic disease characterized by the inability to produce insulin, which results in elevated blood glucose levels. Long-term elevation of blood glucose has been shown to be associated with a variety of short- and long-term complications if not properly managed [1].
- Glycemic control in T1D patients can be achieved either through multiple daily injections or by using insulin pump therapy (IPT) [2].
- However, there is a current lack of real-world data with respect to the differences in effectiveness (i.e., glycemic control) of these different options.

OBJECTIVE

- To investigate the relationship between IPT and HbA1c among patients with T1D.

METHODS

Data Source

- Data from the 2009, 2010, 2011, and 2012 U.S. National Health and Wellness Surveys (NHWS) were used.
- The NHWS is an annual self-administered, internet-based survey from a nationwide sample of adults (aged ≥18 years) that is stratified by gender, age, and race/ethnicity to represent the demographic composition of the U.S. adult population.
  - Each year the sample size was approximately 75,000 respondents.
- All respondents provided informed consent, and the study was approved by the Essex Institutional Review Board, Lebanon, New Jersey.

Sample

- All unique respondents from the 2009, 2010, 2011, and 2012 U.S. NHWS were pooled together for analysis.
  - Since it is possible for a respondent to complete more than one survey over this four-year period, only the most recent data for a given respondent was kept in these instances.
- Among this pool of unique respondents, only those who reported a diagnosis of T1D and reporting using insulin were included in the analyses.

Table 1: ***Sociodemographic Differences Between T1D Patients Using IPT and Not Using IPT***

	Insulin Pump Usage			
	Total (N=1833)	Insulin Pump (N=495)	No Insulin Pump (N=1338)	P Value
Age (years)				*0.059*
Mean ± SD	45.15 ± 15.01	44.06 ± 14.70	45.55 ± 15.11	
Years Diagnosed with T1D				*<.001*
Mean ± SD	22.61 ± 14.36	26.79 ± 13.82	21.07 ± 14.26	
Gender				*<.001*
Female (%)	832 (45.39%)	263 (53.13%)	569 (42.53%)	
Male (%)	1001 (54.61%)	232 (46.87%)	769 (57.47%)	
Race/Ethnicity				*<.001*
Non-Hispanic white (%)	1339 (73.05%)	425 (85.86%)	914 (68.31%)	
Non-Hispanic black (%)	203 (11.07%)	21 (4.24%)	182 (13.60%)	
Hispanic (%)	176 (9.60%)	25 (5.05%)	151 (11.29%)	
Other ethnicity (%)	115 (6.27%)	24 (4.85%)	91 (6.80%)	
Marital Status				*<.001*
Single (%)	790 (43.10%)	177 (35.76%)	613 (45.81%)	
Married/living with partner (%)	1043 (56.90%)	318 (64.24%)	725 (54.19%)	
Education Level				*<.001*
Less than college educated (%)	1140 (62.19%)	270 (54.55%)	870 (65.02%)	
College educated (%)	693 (37.81%)	225 (45.45%)	468 (34.98%)	
Annual Household Income				*<.001*
<$25K (%)	442 (24.11%)	83 (16.77%)	359 (26.83%)	
$25K to <$50K (%)	507 (27.66%)	118 (23.84%)	389 (29.07%)	
$50K to <$75K (%)	372 (20.29%)	116 (23.43%)	256 (19.13%)	
$75K or more (%)	397 (21.66%)	140 (28.28%)	257 (19.21%)	
Decline to answer (%)	115 (6.27%)	38 (7.68%)	77 (5.75%)	
Employment Status				*<.001*
Not currently employed (%)	943 (51.45%)	220 (44.44%)	723 (54.04%)	
Employed (%)	890 (48.55%)	275 (55.56%)	615 (45.96%)	
Health Insurance				*<.001*
Uninsured (%)	229 (12.49%)	21 (4.24%)	208 (15.55%)	
Insured (%)	1604 (87.51%)	474 (95.76%)	1130 (84.45%)	

METHODS, continued

Measures

- Sociodemographics. Each respondent provided information with respect to their sex, age, race/ethnicity, marital status, education, household income, and possession of health insurance.
- Health history. Respondents also provided information as to their alcohol use, smoking behavior, exercise behavior, height and weight (used to calculated body mass index), and years diagnosed with T1D.
- HbA1c. Respondents also provided their HbA1c level. HbA1c was both defined as a continuous measure and as a categorical one (<7%, 7% to <9%, 9% or more, don't know/decline to answer).

Analyses

- Chi-square tests and t-tests were used to test for sociodemographic and health history differences between patients using IPT and not using IPT.
- Multinomial logistic regression models were used to examine the relationships between IPT and HbA1c. IPT was the predictor of interest with sex, race/ethnicity, education, marital status, household income, health insurance possession, employment status, smoking, and years diagnosed with T1D as covariates.
- All analyses used p<.05 as the cutoff for statistical significance.

Table 2: ***Health History Differences Between T1D Patients Using IPT and Not Using IPT***

	Insulin Pump Usage			
	Total (N=1833)	Insulin Pump (N=495)	No Insulin Pump (N=1338)	P Value
Body Mass Index (BMI) Category				*0.613*
Underweight (%)	49 (2.67%)	10 (2.02%)	39 (2.91%)	
Normal weight (%)	683 (37.26%)	195 (39.39%)	488 (36.47%)	
Overweight (%)	548 (29.90%)	145 (29.29%)	403 (30.12%)	
Obese (%)	528 (28.81%)	140 (28.28%)	388 (29.00%)	
Decline to provide weight (%)	25 (1.36%)	5 (1.01%)	20 (1.49%)	
Charlson Comorbidity Index				*0.255*
Mean ± SD	1.70 ± 1.78	1.63 ± 1.97	1.73 ± 1.71	
Alcohol Use				*0.095*
Do not drink (%)	724 (39.50%)	180 (36.36%)	544 (40.66%)	
Drink alcohol (%)	1109 (60.50%)	315 (63.64%)	794 (59.34%)	
Smoking Behavior				*<.001*
Non-smoker (%)	909 (49.59%)	278 (56.16%)	631 (47.16%)	
Former smoker (%)	461 (25.15%)	129 (26.06%)	332 (24.81%)	
Current smoker (%)	463 (25.26%)	88 (17.78%)	375 (28.03%)	
Exercise Behavior				*0.054*
Do not exercise (%)	733 (39.99%)	180 (36.36%)	553 (41.33%)	
Regularly exercise (%)	1100 (60.01%)	315 (63.64%)	785 (58.67%)	

RESULTS

- Of the 1,833 patients who reported being diagnosed with T1D and were currently using insulin, 495 reported using IPT (27.0%).
- Among other differences, patients using IPT were more likely to be female (53.1% vs. 42.5%), non-Hispanic white (85.9% vs. 68.3%), insured (95.8% vs. 84.5%), and to have been diagnosed for longer (26.8 vs. 21.1 years) (see **Tables 1** and **2**).
- Patients using IPT also reported significantly lower levels of HbA1c (7.2% vs. 7.5%, p<.05) (see **Table 3**).
- Adjusting for sociodemographic and health history differences, patients using IPT were significantly less likely to report HbA1c levels 9% or more than to report HbA1c levels <7% (b=-0.80, OR=0.45, p<.05). Although not significant, there was a trend for patients using IPT to be less likely to report HbA1c levels 7% to <9% than HbA1c levels <7% (b=-0.16, OR=0.85, p=.22) (see **Table 4**).

References

1. Sperling MA, editor. *Type 1 diabetes: etiology and treatment*. Totowa, NJ: Humana Press, 2003.
2. Bangstad HJ. ISPAD clinical practice consensus guidelines 2006-2007: insulin treatment. Pediatric Diabetes 2007;8(2):88-102.

Poster presented at the
ISPOR 18th Annual International Meeting
May 18-22, 2013 / New Orleans, USA

CONCLUSION

- T1D patients with greater healthcare access were significantly more likely to use IPT.
- However, even after adjusting for differences in healthcare access and other variables, a significant effect of IPT was observed on HbA1c. Patients using IPT were significantly more likely to be controlled than uncontrolled.
- These results suggest that IPT may be associated with greater real-world effectiveness, though additional research is necessary, particularly around the mechanisms of this relationship.

Table 3: ***Unadjusted Levels of HbA1c Between T1D Patients Using IPT and Not Using IPT***

	Insulin Pump Usage			
	Total (N=1833)	Insulin Pump (N=495)	No Insulin Pump (N=1338)	P Value
HbA1c				*<.001*
HbA1c less than 7% (%)	510 (27.82%)	192 (38.79%)	318 (23.77%)	
HbA1c 7% to <9% (%)	587 (32.02%)	195 (39.39%)	392 (29.30%)	
HbA1c 9% or more (%)	171 (9.33%)	27 (5.45%)	144 (10.76%)	
Missing HbA1c (%)	565 (30.82%)	81 (16.36%)	484 (36.17%)	

LIMITATIONS

- All data were provided through self-report so neither diagnoses nor treatments were verified through objective means.
- The data were also observational, so IPT was not randomized; selection biases may have accounted for differences observed between groups.
- Although the total NHWS sample is broadly representative, the results of the T1D patients may not be generalized to the T1D population.

Table 4: ***Multinomial Logistic Regression Results Comparing Predictors of Different HbA1c Levels***

Variable	Model*	b	OR	x2	p
Intercept	Missing HbA1c	1.089	2.972	14.040	0.0002
	HbA1c 7% to <9%	0.271	1.311	0.840	0.3608
	HbA1c 9% or more	0.107	1.113	0.080	0.7818
Years diagnosed	Missing HbA1c	-0.037	0.963	54.060	<.0001
	HbA1c 7% to <9%	-0.002	0.998	0.190	0.6598
	HbA1c 9% or more	-0.028	0.973	14.810	0.0001
Male	Missing HbA1c	0.067	1.069	0.240	0.6251
	HbA1c 7% to <9%	-0.105	0.900	0.680	0.4093
	HbA1c 9% or more	-0.218	0.804	1.310	0.2518
Non-Hispanic black	Missing HbA1c	0.869	2.384	14.260	0.0002
	HbA1c 7% to <9%	0.259	1.295	1.130	0.2887
	HbA1c 9% or more	0.642	1.901	4.440	0.0351
Hispanic	Missing HbA1c	0.596	1.814	7.160	0.0075
	HbA1c 7% to <9%	-0.453	0.636	3.080	0.0791
	HbA1c 9% or more	0.411	1.508	1.820	0.1774
Other race/ethnicity	Missing HbA1c	0.264	1.301	0.960	0.3277
	HbA1c 7% to <9%	-0.224	0.799	0.670	0.412
	HbA1c 9% or more	0.699	2.012	4.270	0.0388
College educated	Missing HbA1c	-0.365	0.694	6.060	0.0139
	HbA1c 7% to <9%	-0.117	0.889	0.740	0.3886
	HbA1c 9% or more	-0.820	0.441	13.130	0.0003
Married/living with partner	Missing HbA1c	0.138	1.147	0.910	0.3398
	HbA1c 7% to <9%	0.227	1.255	2.760	0.0964
	HbA1c 9% or more	-0.037	0.964	0.030	0.8527
Insured	Missing HbA1c	-0.472	0.624	4.920	0.0265
	HbA1c 7% to <9%	-0.091	0.913	0.170	0.6844
	HbA1c 9% or more	-0.292	0.747	1.110	0.2931
Income: <$25K	Missing HbA1c	0.432	1.541	5.120	0.0236
	HbA1c 7% to <9%	-0.197	0.821	1.110	0.2917
	HbA1c 9% or more	-0.001	0.999	0.000	0.997
Income: $50K to <$75K	Missing HbA1c	-0.020	0.980	0.010	0.9218
	HbA1c 7% to <9%	-0.120	0.887	0.450	0.5039
	HbA1c 9% or more	-0.482	0.618	3.060	0.0801
Income: $75K or more	Missing HbA1c	-0.109	0.897	0.280	0.5976
	HbA1c 7% to <9%	-0.487	0.615	6.740	0.0094
	HbA1c 9% or more	-0.740	0.477	5.920	0.0149
Income: Decline to answer	Missing HbA1c	0.634	1.884	5.000	0.0254
	HbA1c 7% to <9%	-0.210	0.810	0.580	0.446
	HbA1c 9% or more	-0.772	0.462	2.240	0.1349
Employed	Missing HbA1c	0.200	1.222	1.830	0.176
	HbA1c 7% to <9%	0.278	1.321	4.070	0.0437
	HbA1c 9% or more	0.434	1.543	4.520	0.0335
Former smoker	Missing HbA1c	-0.175	0.839	1.150	0.2827
	HbA1c 7% to <9%	0.012	1.012	0.010	0.9361
	HbA1c 9% or more	-0.029	0.972	0.010	0.9035
Current smoker	Missing HbA1c	0.550	1.732	10.340	0.0013
	HbA1c 7% to <9%	0.563	1.755	11.290	0.0008
	HbA1c 9% or more	0.818	2.265	13.010	0.0003
IPT	Missing HbA1c	-0.918	0.399	31.780	<.0001
	HbA1c 7% to <9%	-0.161	0.851	1.440	0.2296
	HbA1c 9% or more	-0.797	0.451	10.890	0.001

**HbA1c <7% served as the reference response option for all models.*