Intentional Insulin Misuse among Individuals with Type 1 Diabetes

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Duke Psychiatry and Behavioral Sciences Grand Rounds

"Intentional Insulin Misuse Among Individuals with Type 1 Diabetes"

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JUROR
Acknowledgements

• Mentorship
  • Nancy Zucker, PhD
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• Members of the Study Team
  • Jim Lane, PhD, Co-Investigator
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  • Jennifer Kuo, BS, Research Assistant

• Recruitment
  • John Buse, MD and the UNC Diabetes Care Clinic
“I just want my wife back”

“I know that it should be enough, that my kids should be enough”

“…diabetic ketoacidosis…”

Type 1 Diabetes (T1D)

- Endocrine disorder in which the immune system attacks the beta cells of the pancreas, eliminating the body’s ability to produce insulin

- Managed with subcutaneous insulin administration (essential for survival); typically combination basal-bolus insulin regimen

- Requires frequent self-monitoring of blood glucose (BG) and calculating needs based on current BG + meal content + ancillary influences
Withholding of Insulin

- 30-40% of young women with T1D withhold insulin to lose weight
- Without sufficient insulin, excess glucose is excreted into the urine
- Early and severe diabetes-related medical complications
- 3 to 14-fold increase in premature death
Withholding of Insulin

- Know very little about this behavior
- Has not been studied systematically, in depth, or in the natural environment
Treatment Approach

- Reliance on conventional treatments for anorexia and bulimia nervosa
- Based on idea that the primary issue is that T1D exacerbates typical risk factors for ED
  - Body dissatisfaction
  - Attention to food/restraint
- Not compelling evidence that these txs improve insulin dosing in the natural environment or HbA1c
Propose we need a sensitive, specific, data-driven model of ED in T1D

- That takes into account factors that influence the momentary decision to withhold insulin
- and make some individuals more vulnerable to an ED under the same conditions.
Insulin omission and diabetes management are diametrically opposed (You can’t do both).

You also can’t be perfect at managing your weight and your diabetes.

You have to choose.
Making the choice: Do I control my diabetes or my weight?

- Having T1D is aversive. Negative consequences are present in daily management and in potential long-term outcomes.
  - No matter how hard you try, you can’t fully account for all the influences on BG.
  - And no matter how good you do, it isn’t good enough.
  - If you turn away from this adversity and toward weight, no one will know. Failure is private.

- Weight
  - Predictable, controllable
  - Outcomes are positive and powerful
  - Success is public (clear to you and everyone around you)
Patient Narratives

- “I can change the number on the scale or my A1c, I choose the scale. I know how to do that.”

- “If I can’t control diabetes, at least I can control my weight”

- BG values get co-opted into the system of avoidance of T1D management:
  - “I am already high, I might as well eat what I want (and not give insulin).”
  - “I am lower (than typical), I might as well eat what I want (and not give insulin).”
The Current Study

- Ecological momentary assessment (EMA) methods to identify antecedents to insulin omission
- Along with a theoretically-driven psychological battery to test vulnerability factors.
  - Focus on how individual differences (e.g., sensitivity to negative feedback, increased compulsion to eat) might increase distress in diabetes and diabetes management and lead to maladaptive avoidance (or turning away to focus on weight control)
Eligibility Criteria

**Inclusion**
- Over the age of 18
- Diagnosed with T1D
- To be part of the clinical group had to screen positive for ED Diabetes Eating Problems Survey-Revised (DEPS-R) ≥20
  - “I feel fat when I take all my insulin”
  - “I try to keep my blood sugar high so that I will lose weight”
  - “After I overeat, I skip my next insulin dose”

**Exclusion**
- Hypoglycemic unaware
- Cognitive deficits that would interfere with self-management of T1D
- Psychosis, substance abuse
Screened N=207

Eligible N=122

- Participated N=63
  - Completed N=60
  - Dropped N=3

- Declined N=59

Ineligible N=85

- Healthy Control N=20
Ecological Momentary Assessment (72h)

- Continuous glucose monitoring (Medtronic iPro2)
- Signal and event-contingent recording of psychological state and behavior
  - Random prompts with automated telephone system @ 1-2/hour
  - Participant-initiated calls for eating
Two Study Visits (3 days apart)

- **Study Day 1**
  - Blood drawn to determine Hemoglobin A1c (HbA1c)
  - Consented for medical chart review
  - Orientated and trained in the ecological momentary assessment (EMA) methods
  - Glucose sensor inserted

- **Study Day 2**
  - Semi-structured diagnostic interview
  - Removal of sensor and data download

(Self-report assessments)
Table 1. *Participant Demographics (N = 83)*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>M (SD) or %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs.)</td>
<td>41.89 (12.43)</td>
</tr>
<tr>
<td>Gender (% female)</td>
<td>88.00</td>
</tr>
<tr>
<td>Race/Ethnicity</td>
<td></td>
</tr>
<tr>
<td>Caucasian/White</td>
<td>86.70</td>
</tr>
<tr>
<td>African-American/Black</td>
<td>10.80</td>
</tr>
<tr>
<td>Asian/Pacific-Islander</td>
<td>1.20</td>
</tr>
<tr>
<td>Hispanic</td>
<td>1.20</td>
</tr>
<tr>
<td>Marital Status</td>
<td></td>
</tr>
<tr>
<td>Never Married</td>
<td>22.9</td>
</tr>
<tr>
<td>Married</td>
<td>63.9</td>
</tr>
<tr>
<td>Separated/Divorced</td>
<td>12.0</td>
</tr>
<tr>
<td>Widowed</td>
<td>1.20</td>
</tr>
<tr>
<td>Highest Level of Education</td>
<td></td>
</tr>
<tr>
<td>High school graduate/GED</td>
<td>6.00</td>
</tr>
<tr>
<td>Some college/technical school</td>
<td>19.30</td>
</tr>
<tr>
<td>Bachelor’s Degree</td>
<td>54.20</td>
</tr>
<tr>
<td>Graduate degree</td>
<td>20.50</td>
</tr>
<tr>
<td>Age of T1D Diagnosis</td>
<td>18.46 (10.73)</td>
</tr>
<tr>
<td>Treatment Regimen</td>
<td></td>
</tr>
<tr>
<td>Insulin Pump Therapy</td>
<td>62.70</td>
</tr>
<tr>
<td>Multiple Daily Injections</td>
<td>37.30</td>
</tr>
</tbody>
</table>
M HbA1c for full sample = 8.8% ± 2.32% (73mmol/mol ± 2mmol/mol)
Traits
- Punishment Sensitivity
- Negative Perfectionism

Eating
- Disinhibition (eating in response to emotions, external cues)
- Susceptibility to Hunger

T1D
- Diabetes Distress
- Diabetes Avoidance
Vulnerability Factors

Traits or Individual Differences
• Traits that may encourage turning away from T1D

• Punishment sensitivity: increased motivation to move away from situations with the possibility of aversive consequences (differentiated from reward sensitivity).

• Negative perfectionism: fear of failure or making mistakes (differentiated from positive perfectionism)
Sensitivity to Reward and Sensitivity to Punishment Questionnaire (SRSPQ)

*p < .01, Cohen’s $d = .90$

![Bar chart showing sensitivity to reward and punishment between clinical and control groups.](chart.png)
Positive and Negative Perfectionism Scale (PANPS)

* $p < .01$, Cohen’s $d = .83$

** ns **
• Individual differences that make it more difficult to manage eating as necessary for T1D (i.e., to be planful re: the timing and content of food intake)

• **Disinhibition**: Decreased ability to restrain eating in the presence of emotions or external cues

• **Susceptibility to Hunger**: Hunger experienced as intense or intolerable and easily triggered
Disinhibition and Hunger scores correspond with frequency of aberrant eating over the 3 day assessment, $r = .42-.62, p < .001$
Traits that increase sensitivity to negative feedback

+ Greater susceptibility to eat more, more often, in a less planful manner

= increased distress in T1D

\[ F(2, 78) = 35.20, \ p < .001, \ \text{Adj } R^2 = .47 \]

(Example, negative perfectionism and disinhibition predicting Diabetes Distress Scale, \( B \ .37 \) and .45 respectively, \( p < .001 \))
Correlation between acceptance % of total eating episodes for which insulin was omitted during the 3 day assessment: $r = -.54$, $p < .001$. 

$F(1,78) = 40.97$, $p < .001$, Adj $R^2 = .34$
Momentary Predictors of Insulin Omission
Signal and event-contingent recording (72hrs)

- Random prompts at the rate of 1-2/hour during waking hours
- Participants initiated calls to report eating at the end of each meal or snack
All Calls

On a Likert scale from 1-6:

- How *happy* do you feel?
- How *sad* do you feel?
- How *frustrated* do you feel?
- How *angry* do you feel?
- How *anxious or nervous* do you feel?
- How *guilty or disgusted* do you feel?
- How *upset are you about your diabetes*?
- How much do you *want to put diabetes out of your mind*?
Eating Reports Only

- When did you start eating?
- Did you eat until you were *uncomfortably full*?
- Did you eat a *large amount of food*?
- Did you *break a food rule*?
- Did you experience a *loss of control* over your eating?
- Do you feel *guilty, shameful or disgusted with yourself for your eating*?
- Did you take *enough insulin* to cover your food?
Compliance

- On average, participants responded to 96.27% of random prompts.
- They called in to report eating an average of 4 times a day ($M_{episodes\ over\ 72hrs} = 12.81$, $SD = 3.62$); 994 total eating episodes.
Insulin Administration Over 3 Days

- Insufficient: 20%
- Unsure: 11%
- Sufficient: 69%

Note: Clinical participants only. Healthy controls reported insufficient insulin for less than 1% of their eating episodes and unsure for less than 0.5%.
Table 2. Blood Glucose (BG) Over 72 hours of Monitoring

<table>
<thead>
<tr>
<th></th>
<th>Clinical M (SD)</th>
<th>Control M (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean BG</td>
<td>189 (58.0)</td>
<td>147 (31.0)</td>
</tr>
<tr>
<td>SD BG</td>
<td>72.2 (19.1)</td>
<td>54.7 (18.3)</td>
</tr>
<tr>
<td>% time &gt;180 mg/dL</td>
<td>38% (21%)</td>
<td>20% (15%)</td>
</tr>
<tr>
<td>% of eating episodes with 2hr postprandial &gt;200mg/dL</td>
<td>49% (28%)</td>
<td>19% (17%)</td>
</tr>
<tr>
<td>% eating episodes with 2hr postprandial &gt;400mg/dL</td>
<td>6% (16%)</td>
<td>0% (0%)</td>
</tr>
</tbody>
</table>
Affect Prior to Eating as a Predictor of Insulin Omission
Data Analytic Strategy

- We synced our 3 sources of data:
  - Event based variables (eating reports)
  - Time-based variables related to participants’ affect experience (random prompts)
  - Time-based variables related to interstitial glucose level (CGM data)

- We excluded eating episodes that occurred when BG was below 70 mg/dL and eating episodes for which these data were missing

- Constrained useable eating episodes to those with affect reports within 60 minutes prior to eating

- Controlled for lag time
Data Analytic Strategy

- Generalized linear mixed models (PROC GLIMMIX SAS 9.3)

- Account for non-independence of observations nested within individuals and parse WP and BP effects
  - **Level 1** – (WP) Time-varying eating occasion variance (variability relative to one’s own mean)
  - **Level 2** – (BP) Variance due to “stable” individual differences (variability relative to the group mean)
**Affect Prior to a Meal (BP)**

*Individuals* who were more prone to heightened negative affect before a meal (relative to the group) were 3-5 times more likely to omit insulin.

<table>
<thead>
<tr>
<th>Affect</th>
<th>Odds Ratio (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sadness:</td>
<td>5.22 (p&lt;.01)</td>
</tr>
<tr>
<td>Anger:</td>
<td>3.94 (p&lt;.05)</td>
</tr>
<tr>
<td>Frustration:</td>
<td>3.87 (p&lt;.01)</td>
</tr>
<tr>
<td>Anxiety/Nervousness:</td>
<td>3.50 (p&lt;.01)</td>
</tr>
<tr>
<td>Guilt/Disgust:</td>
<td>3.82 (p&lt;.01)</td>
</tr>
</tbody>
</table>
Diabetes-Specific (BP)

**Individuals** who were generally more upset or avoidant of diabetes **prior to meal** were 2-3 times more likely to omit insulin.

<table>
<thead>
<tr>
<th>Feeling upset about T1D:</th>
<th>2.15 (p&lt;.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not want to think about T1D:</td>
<td>3.14 (p&lt;.05)</td>
</tr>
</tbody>
</table>
Affect Prior to a Meal (WP)

Higher levels of anxiety/nervousness and guilt/disgust prior to eating (relative to an individual’s typical level) increased odds of omitting insulin for that meal or snack. For every 1 unit increase, odds of omitting insulin doubled.

<table>
<thead>
<tr>
<th>Affect</th>
<th>Odds Ratio (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anxiety/Nervousness:</td>
<td>1.84 ($p&lt;.01$)</td>
</tr>
<tr>
<td>Guilt/Disgust:</td>
<td>1.72 ($p&lt;.01$)</td>
</tr>
</tbody>
</table>
Characteristics of the Eating Episode

(EATING REPORTS)
• Same analytic strategy, except for dichotomous predictors we used grand mean centering

• Slight change in interpretation of the BP effects
  • Unique effect for “person” after controlling for “occasion”
Characteristics of the Eating Episode

Entered simultaneously, individuals who are prone to feel G/S/D about their eating were more likely to omit insulin. Likelihood of omitting insulin were higher for meals/snacks in which a food rule was broken.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>BP</th>
<th>WP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Break a food rule</td>
<td>1.40 (1.76)</td>
<td>2.40*** (0.53)</td>
</tr>
<tr>
<td>Eat Until Uncomfortably Full</td>
<td>3.69 (2.22)</td>
<td>0.47 (0.55)</td>
</tr>
<tr>
<td>Large amount of food</td>
<td>4.94* (2.12)</td>
<td>1.40** (0.53)</td>
</tr>
<tr>
<td>Guilt/shame/disgust re: eating</td>
<td>1.77*** (0.40)</td>
<td>0.53*** (0.15)</td>
</tr>
<tr>
<td>Loss of control over eating</td>
<td>2.17*** (0.53)</td>
<td>0.38** (0.14)</td>
</tr>
</tbody>
</table>

*p < .05  **p < .01  ***p < .001
Actual eating behavior is not as important as whether you experience your eating as something you did wrong (rule violation) or for which you generally feel guilty or shameful.
Post-Omission Affect

- Linear mixed modeling
- Insulin omission predicting continuous outcomes (affect level)
Post-Omission Affect

Omitting insulin at a meal/snack was associated with heightened levels of negative affect post-meal. “Omitters” also tend to be more guilty/disgusted after eating, regardless of whether they omitted.

<table>
<thead>
<tr>
<th></th>
<th>BP B (SE)</th>
<th>WP B (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sadness</td>
<td>.48 (.33)</td>
<td>.28 (.14)</td>
</tr>
<tr>
<td>Anger</td>
<td>.34 (.31)</td>
<td>.45*** (.12)</td>
</tr>
<tr>
<td>Frustrated</td>
<td>.55 (.43)</td>
<td>.65*** (.17)</td>
</tr>
<tr>
<td>Anxious/Nervous</td>
<td>.54 (.40)</td>
<td>.27* (.12)</td>
</tr>
<tr>
<td>Guilty/Disgusted</td>
<td>1.15** (.40)</td>
<td>.57*** (.14)</td>
</tr>
</tbody>
</table>

*p < .05  **p < .01  ***p < .001
Post-Omission Diabetes-Specific

Individuals who omit insulin are generally more upset and avoidant of diabetes. Omitting insulin at a meal/snack is associated with feeling more upset about diabetes (relative to the individual’s typical level) post-meal.

<table>
<thead>
<tr>
<th></th>
<th>BP $B$ (SE)</th>
<th>WP $B$ (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upset about diabetes</td>
<td>1.24* (.49)</td>
<td>.44** (.15)</td>
</tr>
<tr>
<td>Not think about diabetes</td>
<td>1.51* (.66)</td>
<td>.31 (.17)</td>
</tr>
</tbody>
</table>

* $p < .05$  ** $p < .01$  *** $p < .001$
Sensitive to negative feedback/aversive consequences/Fear failure and making mistakes

Focus instead on weight control; Relief is temporary

Upset about ability to manage T1D; Meals become increasingly guilt ridden and anxiety provoking

Decreased ability to restrain eating in presence of emotions and external stimuli, compelled to eat more and more frequently

Focus instead on weight control; Relief is temporary
iOmit: Reducing intentional insulin misuse in T1D
You are at High Risk to omit insulin.

Let your values be your guide.

To be there for my child.

Actions you can take:
- Review additional coping skills
- Check your BG
- Dose insulin, if needed