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“It’s embarrassing. I get angry. I get frustrated.”: Understanding severe hypoglycemia and glucagon usage from the perspectives of people with type 1 diabetes

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ABSTRACT

Introduction: This study characterized the emotional impact of severe hypoglycemia, views of glucagon, and barriers to glucagon use from the perspective of adults with type 1 diabetes (T1D).

Methods: Participants included individuals recruited from the T1D Exchange online community. The current study conducted 7 focus groups consisting of adults with T1D (N = 38, average age 49.4, SD = 16.11 years). Average duration of diabetes was 34.4 years (SD = 17.3) and average self-reported A1c was 6.8 % (SD = 0.7). Focus group interviews were recorded, transcribed, and thematically analyzed.

Results: A range of emotions was expressed about severe hypoglycemia including fear, anxiety, stress, frustration, shame, and embarrassment. Participants frequently identified prescription cost and insurance deductibles as barriers to glucagon use. Participants were also concerned about ease of administration—how difficult it is to prepare the glucagon in an emergency. Many participants expressed a preference for auto-injectables over nasal administration. Timing of glucagon action and time to recovery were high priorities. Some participants, while they had not self-administered glucagon, were interested in a mini-dose glucagon they could self-administer. They also identified desirable characteristics of glucagon treatment including reduced cost, long shelf-life, and quick activation.

Conclusions: These results highlight the attitudes about severe hypoglycemia and emergency treatment with glucagon. Healthcare professionals should assess glucagon training needs and knowledge when they meet with their patients with diabetes.

Introduction

Hypoglycemia and severe hypoglycemia are important health outcomes of type 1 diabetes (T1D). Hypoglycemia is defined as low blood glucose where the person may become disoriented, sweaty, and shaky. Importantly, hypoglycemia promotes worry and concern [1,2], can lead to reduced energy, tense mood [3], cognitive symptoms, morbidity, and mortality [3,4]. Hypoglycemia is very common in people with T1D and estimates vary across populations [5]. Severe hypoglycemia is defined as

a low blood glucose level, <54 mg/dL (3.0 mmol/L), that may lead to a loss of consciousness. Assistance is required to recover. Reports on the frequency of severe hypoglycemia are mixed, such that some people with T1D experience severe hypoglycemia as frequently as once a year [6]. One study found 25 % of participants reported a severe hypoglycemic event in the past 6 months [7]. In addition, severe hypoglycemia is more frequently experienced by older adults [8]. People with T1D are aware of the adverse effects and risks of hypoglycemia which can cultivate fear of hypoglycemia [2,3,9]. Hypoglycemia is feared to a

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similar extent as severe diabetes complications [3,9].

Glucagon is an effective yet underutilized treatment for severe hypoglycemia. Although the production of glucagon by the pancreas becomes impaired in persons with T1D, glucagon can be administered via intramuscular injection, subcutaneous injection, or intranasally [10]. It is recommended that people with T1D keep multiple emergency glucagon devices in different locations, and that they ensure that those in their social circles know where to find it and how to use it [10,11]; (ADA Standards of Care, 2021). Despite the importance of keeping unexpired emergency glucagon treatment on hand, just over half of persons with T1D keep glucagon at home [12]. Furthermore, caregivers underutilize glucagon to treat hypoglycemia because of lack of education about its effectiveness and training in its administration [10], and fear of harming the person experiencing hypoglycemia [11].

To date, aside from fear and embarrassment, the cognitive and emotional dimensions of hypoglycemia experiences in persons with T1D are understudied. Barriers to glucagon utilization have mostly been studied from the perspective of a caregiver of a child or person with T1D or spouse of person with T1D. This is a significant knowledge gap given that adult persons with T1D are often the ones responsible for acquiring glucagon and training others to administer the emergency glucagon. Thus, it is critical to understand emotions related to hypoglycemia experience and barriers to glucagon use from the perspective of the adult person with T1D to promote glucagon maintenance and more effective use. The current study's objectives were to understand the emotional impact of severe hypoglycemia and current perceptions of emergency glucagon usage. Currently, there is a dearth of research characterizing the impact (including emotional dimensions) of hypoglycemia and their associations with glucagon.

Methods

The present manuscript summarizes the findings from a focus group study to further understand the emotions about glucagon usage and overall experiences using glucagon rescue treatments. These focus groups occurred between October and December of 2020 in a virtual environment in the US. Research questions included: 1) *What emotional impact has severe hypoglycemia had on their diabetes management and daily living?* 2) *What do people with T1D prioritize regarding glucagon characteristics (e.g., time to recovery)?* 3) *What are their perceptions of current emergency glucagon on the market?*

Participants

Seven focus groups with 5–7 participants per focus group were conducted. A total of 38 people participated. Inclusion criteria for participation were the following: being over the age of 18, having been diagnosed with T1D for over one year, currently on an insulin regimen, at least one episode of severe hypoglycemia (defined as a low blood sugar event where assistance was required) in their lifetime, being familiar with current glucagon options on the market, currently residing in the United States, fluent in written and spoken English, and agreeing to provide informed consent. Participants were recruited from the T1D Exchange online community and T1D Exchange Registry. Participants were sent recruitment emails; promotional study material was available on the T1D Exchange online community and T1D Exchange Registry websites.

Measures and procedure

Participants completed an online screener with availability for focus group attendance. The research assistant scheduled the focus groups via email and Calendly. Focus groups were conducted online using the video conferencing application Zoom. Additionally, verbal consent was obtained prior to recording the focus groups. A semi-structured discussion guide was developed to ensure key topics were covered during each

focus group (see Appendix A). The focus groups were conducted by AH, JB, and KC in a conversational style. All participants were given the opportunity to answer questions and interaction between participants was encouraged to elicit robust insights. Per focus group methodology, participants responded to prompts and shared anecdotal information from other participants. Each focus group lasted approximately 90 min in duration. Participants were each remunerated with a \$100 Amazon gift code to compensate for their time. Once all focus groups were conducted and audio recording retrieved, the recordings were transcribed by TranscribeMe!, a HIPAA and IRB compliant transcription company. All identifiable information was removed from the transcripts prior to analyses. This study was approved by Western IRB.

Data analyses

Focus groups were recorded and transcribed verbatim. AH and KC reviewed the transcriptions to ensure accuracy. A codebook was developed both inductively and deductively based on previously collected interview data. Insights from the interview data included themes of: the daily impact of hypoglycemia on everyday life, emotions about glucagon usage, glucagon characteristics that would make glucagon easier to administer. AH and KC then thematically analyzed the textual data [13–12]. The coders used a flexible qualitative data analysis framework that aimed to improve precision and contextual fit. A phenomenological qualitative approach was used with this project. 2 coders reviewed and coded the data. Coding differences were settled by reaching consensus on each code. Coders identified patterns and themes found among the participant quotes and met to discuss. Themes were added to the codebook as needed. Themes were then defined, reviewed, and finalized. AH reviewed all codes to ensure accuracy. Coders were also the focus group moderators.

Results

A total of 38 people with T1D participated in one of the seven focus groups. Half of participants were females, 84 % of participants used continuous glucose monitoring. Participants were able to endorse multiple types of insulin administration. Participants reported 63 % used pumps, 47 % used multiple daily injections of insulin, and 3 % used inhalable insulin. Average participant age was 49.4 years ($SD = 16.11$), average duration of diabetes was 34.4 years ($SD = 17.3$), and average A1c was 6.8 % ($SD = 0.7$).

Experiences and emotions regarding severe low blood sugar

Participants described their experiences with severe low blood sugar, fear, stress, and worrying affects people around them who have to help them. They also worry about impacting friendships and family relationships.

“My last 911 call, I was in the low 60s and I was breaking out in a sweat [...] it was Christmas with family and it didn't go that way. They ended up having to call the paramedics, and after three things of the glucagon gel given to me by the paramedics, I finally started coming up. But at that point you're stressed, it's embarrassing, even though it shouldn't be. It still feels like that when the paramedics have to be called.”

Participants described feelings of embarrassment, guilt, and anger about lack of control:

“Yeah, frustrated, angry. You feel kind of ashamed almost, like, “I should know better. At this point, why the hell am I letting this happen?” But logic tells me, “Hey, shit happens.” Sorry. But then at the same time, you still kind of just beat yourself up over it, because you figure after having diabetes this long, we should have it figured out. And the reality of it is, we don't. We just don't have it figured out, and it's really frustrating and overly humbling. It's embarrassing. I get angry. I get frustrated. And yeah,

it's overwhelming to be an adult at this stage at my life and be dependent. I find that humiliating at best."

These emotions were also associated with feelings of weakness, dependence on others, and sadness. Participants communicated feelings of panic and anxiety regarding severe hypoglycemia and how these feelings led them to overtreat, resulting in a high blood glucose:

It's that sort of panicky. And I think that could contribute to some of us over indulging in trying to deal with the low blood sugar. It's very hard to say, "Okay, I'm just got eat two lifesavers, and we'll see how it goes," or one glucose tablet and then I'm good. I had a low the other day, and next thing I know I had six glucose tablets and I quickly realized I was really in trouble after that, because I was now going to go too far the other direction.

Another participant expressed a similar experience while traveling when they had to self-administer:

So the one time I had to use it was on a plane, and after—I think I was low for like an hour. I was drinking juice. I was eating. And I was just kind of panicked because I was on a plane, and I was like, "Okay, I need to bring my blood sugar up." And then afterwards, I was vomiting for hours afterwards. And it was horrible. And ever since that experience, I'm like, "I don't ever want to use glucagon again." I actually had a really bad low this summer at a clinical rotation. My blood sugar got down to 26. And my clinical preceptor drew up a shot of glucagon, and I was like, "I am not taking that." [laughter] So I kept eating until my blood sugar came up because it was just horrible.

Ease of administration

Participants mentioned concerns regarding length of time from severe hypoglycemia to administer glucagon. Concerns regarding ease of administration of glucagon products included the complexity of preparation of glucagon in an emergency situation.

I think for me the problem is how difficult it is to prepare; concern that the person who's taking care of me, even if they know me really well, is going to panic and can't quite figure out the instructions and drop the bottle and drop the needle... or if they don't [know] me that well, is going to look at it and say, "Holy crap. No, I'm not doing that." I think those are— or they can't find it. Those are the problems for me.

Perceptions of glucagon

Participants stated that they did not feel the need to keep glucagon in the house because glucagon is the "last resort option" and they have never needed it before. Another reason for this choice was that they lived alone and there was no one to administer the glucagon. One participant stated that glucagon was seen as the very last possible option in their severe hypoglycemia treatment plan:

I think one thing is that glucagon is always kind of like the nuclear option. And so I would basically never give it to myself because if I'm still conscious, then I'm still able to eat. And I would obviously rather eat something than have a big injection of something.

Perceptions of timing

Participants expressed that they prefer a faster glucagon: "At this point, I would go for the speed... Other people, you're saying how they used a partial glucagon injection, and I've contemplated that. So that's important too. But again, the speed. The speed." Other participants expressed how important both the timing of glucagon action and the time to recovery are:

I think it's obviously important if we were going to use it. But I think over the years, most of us have learned it's just not a practical thing to wait for. Anything you have, whether it's the glucagon or the Snickers bar or the package of Smarties, you want it to work quickly and be effective and not give a lot of residual things like that nasty hangover headache that you end up with or some other awful feeling from the rebound.

One participant expressed that time to recovery was more important than any other aspect of glucagon: "Yeah. Because if you're taking glucagon, you're in a place where you need to recover ASAP. So that's the primary concern is how fast you recover from a low." Other participants felt strongly about the time to recover: "The recovery quickly is the main thing."

Participants described that they would prefer an effective glucagon over a quick recovery: "if I'm in bad enough shape to need glucagon, I don't care whether it takes 2 min or 20 min. Those 18 min, I don't know where I am. I don't know what's going on. I don't care." Another participant expressed a similar sentiment:

Yeah, I think that's right. It does work. And I'm told it works very quickly. But as [redacted] said, I mean it takes me a couple of hours to come back from a low that's bad enough for me to need help. It just does. And whether I got back up in 2 min or 20 min, it doesn't matter to me.

Participants also emphasized the importance of restoration of consciousness: "Huge. I mean, that's back down to seconds. The difference between a minute can be huge. Like [redacted] said, those are just brain cells that are just burning away like fumes."

Cost

When prompted to discuss why they did or did not fill their glucagon prescriptions, participants across each focus group consistently discussed the cost of filling glucagon at the pharmacy. Concerns about glucagon affordability included lack of insurance coverage for certain forms of glucagon including nasal glucagon: Cost of filling the prescription was not limited to financial impact, but also other concerns including shelf life. One participant stated:

If you do not use it, it's going to expire. The cost of prescriptions in this country is outrageous. And with people losing their jobs and everything in this pandemic, cost is a big thing. And having it expire, you have to keep purchasing it.

Self-administration experience

Multiple participants depicted their experiences self-administering glucagon to prevent or treat a severe hypoglycemic event in a variety of situations. One such participant, who also has celiac disease, described a situation when they were traveling and had an experience of hypoglycemia as a result of accidentally eating something that contained gluten.

"Yes. I did once. So I also have celiac. I was traveling and got some food that was not gluten-free, and I was very sick. And I couldn't keep food down. And of course, I had given myself a bolus of insulin for the carbs that I ate that I did not keep down until after calling my physician. She was like, "Just take a glucagon." And I so I did. I gave it to myself so that I could maintain a good blood sugar. And I took half of a dose."

CGM and hypoglycemia

Participants consistently discussed how continuous glucose monitoring (CGM) technology assisted them in navigating severe hypoglycemic events, especially when they are not aware of the drop in blood glucose.

I found the CGM has been really helpful as far as normally noticing my lows are coming. I feel like between the pump and the CGM, it's helped me keep from having too many of the lows, like these gentlemen have said. But for me, one thing I have struggled with is the least amount of activity, and my blood sugar drops. And that's been a challenge for me because I don't notice the low blood sugar coming until I'm below 70.

Mini-Dosing

Some participants, while they had not self-administered glucagon, expressed interest in a mini dose glucagon they could self-administer:

"I would love a premixed-ready-to-go. And maybe, I mean, if it could be a half dose. And so if I was hitting 50 and going down, I think I would reach for glucagon if I knew I could get a half dose and I didn't need a full rescue dose. But there's no way I'm going to try to—I mean, it's the same thing of over shooting because glucagon isn't glucose the way it interacts, and the metabolic is all different. But I also have— what I'm, now, discovering is really good employment insurance and health insurance. And so mine, some years it's been zero-pay co-pay. Right now, it's 25, and I can get four or five a year. And if I told them I needed more, they would buy me more."

Mode of delivery

Participants were asked if they would prefer a different way of administering glucagon and many suggested a preference for auto-injectables. One participant stated: *"I would prefer the autoinjector. I have a slight history of asthma, very slight. But there's lots of people with breathing issues, and I don't know how the nasal glucagon is going to affect that. But I can't get the other one, so I'm going to have a nasal one right now."* Others also agreed with this statement: *"Yeah, I think that's a great idea. I have several different types of auto-injectors I take for different things, and they work very easily. There's really nothing to them."*

One participant stated that they think an autoinjector would be helpful when they are experiencing anxiety: *"Yeah. I think I would prefer the autoinjector too. I think in situations where I'm panicking, I probably wouldn't want to mess around with a inhalation thing and wondering if I inhaled the right way or any of that as opposed to an injector when I can be sure that it's in or it's not."* Another participant expressed preference to the autoinjector over the nasal application because it would be similar to an EpiPen:

"I think my preference would be for that. I mean, yes, the bruise sucks, but for someone else having to administer it, it just seems more instinctual for them to know—it's very similar to an EpiPen, which, I don't know, for years, everybody's been engineered to just slam that into a thigh, and it goes. Whereas an inhaler, you have to get the person to breathe that in, and if their autoimmune systems are shutting— or not autoimmune, but their autonomous systems are shutting down, they're not able to swallow. They're not able to breathe correctly. Then I worry about enough of it getting into the blood stream fast enough whereas the auto-injector kit seems to be something that would get into the blood faster. But I don't know enough about either one. That's just kind of my guess at this point."

One participant expressed that the nasal application of glucagon might be better and also voiced concerns about possible allergies: *"I don't know. I'm just concerned about the nasal glucagon because I don't know if there are any allergic reactions to it. I don't know very much about it. So that's been at the back of my mind. I don't know how it compares to the red box glucagon, or red kit. But I guess it does, hopefully, prevent having the big old bruise or whatever. But I mean, I don't think it matters. I think the biggest thing is that it is a little bit easier to use because it does not have the mixing involved."*

Discussion

Overall, participants described experiencing a high amount of stress, worry, and concern due to experiencing severe low blood sugar. Several participants described a mix of emotions: fear, stress, worry, concern, panic, anxiety, embarrassment, guilt, sadness, anger, shame, and frustration. While participants expressed similar feelings of emotions, life experiences were very individualized and differed between participants. Participants expressed concerns regarding glucagon including the cost and insurance coverage, as well as ease of administration, practicality, and the timing. Financial cost, often determined by their insurance companies, or lack of insurance, and was a hinderance on participants' ability to acquire glucagon. There were a few participants who had good insurance coverage and did not have this barrier for obtaining glucagon.

Participants overwhelmingly stated that an easy to administer glucagon is very important, as severe hypoglycemic events can be stressful for all involved. There were many participants who thought glucagon was not practical; due to living alone, never having to use glucagon since diagnosis, and the cost of glucagon. The timing of glucagon was also important for most participants as they desired a faster time to recover consciousness, a faster time to action, and a shorter time to recover after being administered glucagon.

Findings from the present study begin to fill the knowledge gap of cognition and emotions experienced by adults with T1D around hypoglycemia, addressing the previously identified dearth in knowledge [2]. The current research builds on the established association of fear of hypoglycemia with greater variability in glycemic management, consumption of more calories, and less moderate to vigorous physical activity [15] by elaborating on how emotions around hypoglycemia and its emergency treatment affect engagement in glycemic management behaviors. Results from the present study allow the field to move forward towards understanding and addressing hypoglycemia as a barrier to achieving glycemic targets.

Limitations and future directions

Despite the importance of the current findings, there are some limitations to note. First, the sample size was relatively small and may overrepresent persons who are well connected to the diabetes community. Due to the nature of this study, generalizability should be limited as this was a convenience sample. On average, participants represented a middle-aged demographic and had diabetes for the majority of their lives so they were more experienced with managing their diabetes. Much is learned from examining the experience and challenges faced by experienced persons, however their experiences may not generalize to younger persons with T1D. Furthermore, participants were mostly white. Future research recruit persons from other ethnic and racial backgrounds to examine the extent to which these themes generalize across all persons with T1D as well as to identify experiences and barriers to hypoglycemia management and emergency treatment uniquely experienced by minority persons with type 1 diabetes.

Conclusions

The findings of the present study add to the knowledge base a deeper understanding of the emotional and practical impact of hypoglycemia and emergency glucagon usage from the perspective of the experienced adult with T1D. In summary, participants highlighted emotions around experiencing and treating severe hypoglycemia. The glucagon market could benefit from taking these psychosocial aspects of disease management into consideration with product design. People with diabetes would benefit from their healthcare professionals educating them about glucagon.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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