



# Perceptions About Glucagon Delivery Devices for Severe Hypoglycemia: Qualitative Research With Patients, Caregivers, and Acquaintances

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## ABSTRACT

**Purpose:** People with diabetes taking insulin are at risk of severe hypoglycemia, an unpredictable, life-threatening event that requires assistance from others. Outside the clinical setting, glucagon is indicated for the treatment of hypoglycemia. However, there is significant unmet medical need to improve successful administration of glucagon by caregivers and acquaintances. This study assesses perceptions about glucagon delivery and potential effects of 2 glucagon delivery devices for severe hypoglycemia.

**Methods:** Qualitative interviews were conducted with people with diabetes (patients), caregivers, and acquaintances from a general population panel composed of individuals across the United States who have agreed to be recruited for research studies. Participants were recruited via email with a link to an online screener to determine eligibility. Experienced qualitative researchers conducted telephone interviews after a semistructured discussion guide, developed by the authors, that focused on aspirational device features and perceptions about the 2 devices: nasal glucagon and autoinjector glucagon; visuals of the instructions for use were displayed. Verbatim transcripts were developed, and a qualitative analysis software program, MaxQDA, was used to code responses and themes that emerged from the data.

**Findings:** A total of 45 (15 patients, 15 caregivers, and 15 acquaintances) interviews were conducted (mean ages, 55, 40, and 51, respectively). The most frequently spontaneously identified aspirational features for a new glucagon device were ease of use

(29 [64%]), including being uncomplicated, premixed/ready to use, and ability to use quickly; small/easy to carry (9 [20%]); needle-free/no long needles (8 [18%]); and easy instructions (4 [9%]). In general, participants indicated that having a glucagon delivery device on hand would make them feel prepared, protected, and confident that others could assist in the event of severe hypoglycemia. More participants across all subgroups preferred nasal glucagon versus autoinjector glucagon (33 [73%] vs 12 [27%]). Favorable comments about nasal glucagon included that it appeared to be easy to carry, easy to use, and lacked a needle, that one does not need to remove clothing to use it, and that others likely would be more comfortable using it. Favorable comments about autoinjector glucagon included that it was familiar as a rescue device and that patients felt confident that the full dose would be delivered with it. There may be more hesitation using autoinjector glucagon versus nasal glucagon because of anxiety about needles and locating an injection site. Participants indicated that they would feel more comfortable socially using nasal glucagon because it was viewed as more discreet and less embarrassing than using autoinjector glucagon; it was also considered less traumatic for use in children.

**Implications:** This research suggests that patients with diabetes, caregivers, and acquaintances prefer a

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device that is simple, compact, and ready to use. Nasal glucagon was generally preferred over autoinjector glucagon primarily because it lacks a needle and it appears to be less complicated. (*Clin Ther.* 2019;41:2073–2089) © 2019 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

**Keywords:** hypoglycemia, glucagon device preferences, nasal glucagon, qualitative.

## INTRODUCTION

Severe hypoglycemia involves having low blood glucose levels such that an individual is in an altered mental and/or physical state and hence requires the assistance of another person.<sup>1,2</sup> It is an unpredictable and life-threatening event that can occur in people with diabetes who take insulin. Severe hypoglycemia affects 30% to 40% of adults with type 1 diabetes mellitus (T1DM) and 7% to 15% of adults with type 2 diabetes mellitus (T2DM) annually.<sup>3,4</sup> The prevalence of severe hypoglycemia episodes in patients with T2DM taking insulin is estimated to be 21%,<sup>5</sup> and the frequency of occurrence increases with disease duration as treatment intensifies and pancreatic  $\beta$ -cell failure progresses.<sup>6,7</sup> Severe hypoglycemia may affect physiologic functioning, leading to myocardial ischemia, cardiac arrhythmias, coma, seizures, and convulsions, as well as vascular events, such as hemiplegia and cognitive dysfunction.<sup>7,8</sup> It is responsible for 4% to 10% of all deaths in patients with T1DM.<sup>1</sup> One study found that among patients with T2DM those who experienced severe hypoglycemia were 2.7 times more likely to die of a cardiovascular cause and 2.7 times more likely to die of any cause than those who did not experience severe hypoglycemia.<sup>8</sup>

Severe hypoglycemia may lead to fear, anxiety, sleep issues, disruptions to domestic and social life, and decrements in quality of life.<sup>7,9</sup> Fear of severe hypoglycemia episodes influences many people with diabetes to reduce glucose control or frequency of monitoring, which, in turn, might increase the risk of complications.<sup>6,9,10</sup> Although self-ingestion of oral carbohydrates is an effective treatment for

asymptomatic hypoglycemia and most episodes of mild to moderate symptomatic hypoglycemia, without treatment, mild and moderate hypoglycemia may progress to severe hypoglycemia.<sup>2,11</sup> In 2018, outside a clinical setting, injection of 1 mg of glucagon via a needle and syringe by another person was the only available treatment for severe hypoglycemia.<sup>12,13</sup> The limitation with this method is that glucagon is unstable in solution; thus, the current glucagon emergency kits are complex, requiring the user to reconstitute a lyophilized powder in a diluent and then deliver it via intramuscular or subcutaneous injection.

The multiple steps required in preparing glucagon for administration via needle and syringe, coupled with the high-stress situation of a severe hypoglycemia episode, may constitute a significant obstacle for caregivers or others who might be trying to help the affected individual. Errors in handling, including difficulty in opening the pack, sheath removal, mixing, and damaging the needle, and in administering the full dose of glucagon have been experienced.<sup>12,14,15</sup> Moreover, caregivers or acquaintances may not have received education on how to use the glucagon kit or may have a fear of needles and, as a result, may be too frightened to administer glucagon.<sup>16–19</sup> In a simulated glucagon administration study that included 136 parents of teenagers or young children with diabetes, 69% had handling difficulties that ranged from opening the container and mixing to drawing the correct dose into the syringe.<sup>15</sup> In addition, an analysis of health care costs associated with severe hypoglycemia in the United Kingdom, Spain, and Germany found that these costs contributed substantially to the overall health care costs of diabetes across the 3 countries. The costs included hospitalizations, telephone calls, physician visits, blood glucose monitoring, and patient education.<sup>18</sup> Similarly, it was found that hospitalized treatment of hypoglycemia episodes among patients with T2DM in Sweden costs approximately 10 times more than those treated in the community.<sup>19</sup>

There is a clear unmet need for a more practical and easy-to-use method of glucagon delivery during a severe hypoglycemia episode. New products are being developed to address this need. These methods include nasal glucagon, which is a dry powder ready-to-use synthetic glucagon,<sup>20</sup> and an autoinjector

glucagon, which delivers a room-temperature stable liquid glucagon.<sup>21</sup> Because assumptions about which features would be important to end-users may not always be accurate, it is critical to holistically integrate their feedback to fully understand preferences for medical devices.<sup>22</sup> This study sought to qualitatively understand perceptions about glucagon delivery devices and potential effects of different delivery devices for severe hypoglycemia, specifically nasal glucagon and autoinjector glucagon, from the perspective of the patient, caregiver, and acquaintance.

## METHODS

This cross-sectional, qualitative research study that involved one-on-one telephone interviews was conducted with people with diabetes, caregivers, and acquaintances, recruited via a general population panel, managed by Focus Pointe Group. The panel is composed of individuals across the United States who have agreed to be recruited for research studies. Panel members were recruited into the panel through a variety of methods, including referrals from current panel members, social media advertising, online advertising, associated or user groups, article or blog submissions, and grassroots outreach. Panel members were identified for possible inclusion into the study based on self-identification of being a patient with diabetes or being a caregiver; the general population was targeted for recruitment of acquaintances. Panel members received an e-mail with a general introduction to the availability of a new study, and those interested completed an online screener, which was custom developed for the purposes of this study. The screener included a question asking potential participants to select which condition(s) they have from a list; those who did not select diabetes were asked if they are a caregiver of/or know someone who has any of the conditions from the list. If an interested individual qualified for the study, the screener provided an introduction that explained the purpose and scope of the study. If the individual indicated their interest in participating, a recruiter contacted him/her to schedule the telephone interview.

All participants were 18 years or older. Patients had self-reported T1DM or T2DM and were currently

taking insulin. Caregivers were individuals who live with or help a person who has diabetes and provide care on a regular basis for diabetes. Acquaintances were individuals who know a person with diabetes but do not provide care on a regular basis for their diabetes. Caregivers and acquaintances were excluded if they were paid to stay with the person with diabetes. Professionally licensed health care professionals, as well as employees of pharmaceutical companies, also were excluded.

Four trained interviewers used a semistructured interview guide developed jointly by the authors based on previous research and the study objectives. The interview guide included open-ended questions that focused on the following: (1) awareness of severe hypoglycemia and glucagon; (2) a visual of a description of severe hypoglycemia,<sup>23</sup> which was displayed via secure desktop sharing to ensure that all participants fully understood its severity and that a person with severe hypoglycemia requires assistance from another person; (3) aspirational features of a potentially new glucagon delivery device; and (4) visuals of draft instructions for use for nasal glucagon and autoinjector glucagon. The order in which these instructions were displayed were randomized (Figure). While displaying each visual, participants were asked about their thoughts about the device, including their perceived ease of use and how it would feel to have the device in the event of a severe hypoglycemic episode. Direct preference elicitation questions were asked regarding which device was most preferred, would make participants feel more prepared, would cause more hesitation, and would be most preferred to use on children (because the interview guide served only to help guide the discussion, all participants were not necessarily asked all the direct preference questions). All participants provided informed consent, and the study protocol received exempt status from the Sterling Institutional Review Board (September 28, 2018; Indianapolis, Indiana). The interviews were conducted from October 8 to 26, 2018.

Verbatim transcripts of the interviews were analyzed to identify key concepts that emerged from the data. MaxQDA, version 11.0, a qualitative analysis software program, was used to code the transcripts and organize the data. Specifically, a thematic analysis

A



# GLUCAGON

3 mg

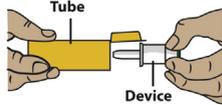
nasal

## 1. PREPARE

Remove the shrink wrap by pulling on red stripe.

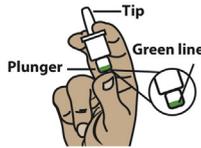


Open the lid and remove the Device from the Tube.



## 2. SPRAY

Hold the Device between fingers and thumb. Do not test before use.



Insert the Tip gently in one of the nostrils until finger(s) touch the outside of the nose.



• Push the Plunger all the way in.  
• The dose is complete when the Green Line is no longer showing.



## 3. ASSIST

Turn Patient on Side.  
Call for Medical Help.



B

# GLUCAGON

1 mg

autoinjector

## 1. PREPARE

Tear Open Pouch and Remove Device. Tear at Notch.

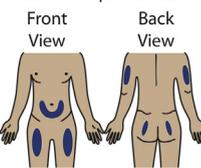


Pull off Red Cap.

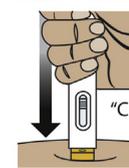


## 2. INJECT

Choose Injection Site and Expose Skin.



Push Down on Skin to Start. Hold Down for 5 Seconds. Wait for Window to Turn Red.



Hold Down for 5 Sec.



## 3. ASSIST

Turn Patient on Side.  
Call Doctor.



### Needle End

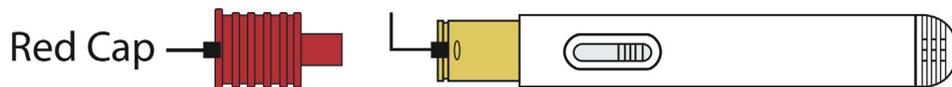


Figure. Draft instructions for using nasal glucagon<sup>24</sup> (A) and autoinjector glucagon (B).<sup>25,26</sup>

was performed to identify underlying concepts, which were each given a code. Open-ended questions generating spontaneous feedback included, “What are your thoughts about this device?” “In thinking about the two devices, what are the most important differences in your opinion?” “What about

[participant’s preferred device] makes it more preferred?” Each participant was interviewed once, and the respective data were evaluated for any new information or concept that was not already raised by previously interviewed participants. Saturation, the point at which no new key concepts are identified with

each successive interview, was attained with respect to important aspects of each device by the 13th interview for nasal glucagon and by the 10th interview for autoinjector glucagon.

## RESULTS

A total of 21,621 respondents were reached via email to assess their interest and eligibility for this study. Of these, 6315 completed the online screener, and 2587 did not qualify based on eligibility requirements. Most of these respondents disqualified because they did not have T1DM or T2DM or did not provide care for or know someone with these conditions ( $n = 2348$ ). Six respondents were disqualified because they were younger than 18 years, 24 were disqualified because they did not have the necessary access to a telephone and computer, and 8 were disqualified because they were employed by a pharmaceutical company. Forty-five respondents qualified but declined to participate. From the remaining pool of qualified, interested respondents ( $n = 1297$ ), 45 were selected based on a first-come, first-serve basis and time and date availability.

The participants included 15 patients, 15 caregivers, and 15 acquaintances. Among the patients, 47% and 53% reported having T1DM and T2DM, respectively. Most participants (87% patients, 93% caregivers, and 93% acquaintances) indicated that they were familiar with severe hypoglycemia, and they described it as when sugar levels drop very low. Approximately half of the patients reported past experience with a severe hypoglycemia episode (Table I).

The most common symptoms and/or outcomes of severe hypoglycemia identified included being unconscious or passed out, being confused or disoriented, having body shakes, sweating, having incoherent speech, having dizziness, and death. Most participants first learned about severe hypoglycemia from direct experience, a physician, or diabetes education classes. A total of 30 participants (67%) were concerned about future severe hypoglycemic episodes; in particular, they were concerned with the patient being alone at the time and not having anyone around to help, an episode occurring while driving, and the unpredictability of the event:

His diabetes is not very well controlled, even though he's had it for 40 years. He's on a good regimen; he pretty much does everything he's supposed to do, but these episodes can come on at any time. I haven't really been able to figure out what triggers them, so it's very unpredictable and it's definitely concerning.—Female caregiver of patient with T2DM (age, 55 years)

I might catch it too late. I might not know that he's going through it and not know or not wake up in time, so to me that is more scary [compared to hyperglycemia].—Female caregiver of patients with T1DM (age, 39 years)

Many felt that a severe hypoglycemic event was likely to occur in the future, with reasons including getting too busy and not eating during the day, exercising and not eating enough during the day, inaccurately administering their insulin because of advanced age, diabetes not being very well controlled, and not eating properly:

I think there's a chance of it happening every day, because I do take insulin and I do exercise and sometimes I don't eat enough, or I don't have enough food in my system. It can happen at any time, so I fear that every day.—Female patient with T1DM (age, 38 years)

It could be anything that triggers it. You think you start the day off right. You start going about your business and then all of a sudden you have this low.—Female patients with T1DM (age, 49 years]

A total of 19 participants (42%) had knowledge about currently available glucagon devices. Eleven participants (24%) reported having such a device, and they used terms such as *safe*, *secure*, *prepared*, and *confident* when describing their readiness for a severe hypoglycemic episode:

It makes me feel a little more secure [T1DM Patient, Male, Age 49]

Table I. Demographic and clinical characteristics.

Characteristic	Patients (n = 15)	Caregivers (n = 15)	Acquaintances (n = 15)
Participant age, y			
Mean (SD)	54.9 (10.3)	40.1 (10.0)	50.6 (13.4)
Range	37–73	24–63	18–74
Age of patient known/cared for			
Mean (SD), y	NA	43.3 (24.2)	40.7 (25.6)
Range		11–80	3–81
Diabetes type, No. (%)			
Type 1	7 (46.7)	10 (66.7)	10 (66.7)
Type 2	8 (53.3)	5 (33.3)	5 (33.3)
Insulin type		NA	NA
Bolus	6 (40.0)		
Basal-bolus	5 (33.3)		
Mix/premix	3 (20.0)		
Insulin pump	1 (6.6)		
Experience/familiarity with severe hypoglycemia			
Have not experienced severe hypoglycemia	7 (46.7)	NA	NA
Experienced severe hypoglycemia	8 (53.3)	NA	NA
Not at all familiar	NA	1 (6.6)	0
Not very familiar	NA	0	1 (6.6)
Somewhat familiar	NA	1 (6.6)	9 (60.0)
Very familiar	NA	10 (66.7)	5 (33.3)
Extremely familiar	NA	3 (20.0)	0
Comorbid conditions*		NA	NA
Allergies	4 (26.7)		
Anxiety	3 (20.0)		
Arthritis	7 (46.7)		
Chest pain	1 (6.6)		
Chronic kidney disease	2 (13.3)		
Depression	2 (13.3)		
Gastroesophageal reflux disease	1 (6.6)		
High cholesterol	6 (40.0)		
History of myocardial infarction	2 (13.3)		
Hypertension	8 (53.3)		
Osteoarthritis	1 (6.6)		

NA = not applicable.

\* Not mutually exclusive.

I feel more confident in case something happens I'm prepared. Like carrying around a first aid kit [T1DM Patient, Female, Age 58]

I feel good that I have the tool and the equipment to be able to handle it, without calling 911, because it's a lot faster [T1DM Caregiver, Male, Age 63]

Most participants without a glucagon device generally reported not having a plan in case of a severe hypoglycemic episode. Most described “catching it” before their glucose levels got too low and consuming or giving the patient food or drink or “glucose tabs” to bring their levels back up, and a couple of participants mentioned they would call emergency services (ie, 911):

No. I don't have a plan, because I don't even know it's going to come like that.—Male patients with T1DM (age, 60 years)

No, you're never ready. It catches me off guard. I just run in the breakroom, which is right here. I tell one of my co-workers to grab me a soda, and they do it immediately.—female patient with T2DM (age, 51 years)

I'd call 911. I've seen her go low before, 50s. Starts pounding the orange juice, drinking the orange juice, she's sweating, shaking, all that.—Male patient with T2DM (age, 38 years)

### Aspirational Device Features

Before being shown the draft instructions for use for nasal glucagon and autoinjector glucagon, participants were asked what features they would like to see in a new glucagon device (Table II). They most frequently indicated that they would want the device to be easy to use (29 [64%]). Characteristics that would make a device easy to use included that it was premixed and can be used quickly:

If they can have it like a pen with the injection already prepared where you just take the cap off of it and you push the button. That would be more convenient.—Male patient with T1DM (age, 37 years)

I would think if you wouldn't have to mix it, that would be nice.—Male acquaintance of patient with T1DM (age, 62 years)

As long as it's not a long needle, and it's premixed, I'm all for it.—Male caregiver of patient with T1DM (age, 38 years)

The ability to easily carry the device and the device being a manageable size were important characteristics for 9 participants (20%):

I would say number one, portability.—Male caregiver of patient with T2DM (age, 38 years)

Ease of use, not something that's going to be too big and cumbersome.—Male acquaintance of patient with T1DM (age, 52 years)

Eight participants (18%) indicated that the new device would not have a needle or a long needle, with some suggesting that this likely would make it easier for other people:

Something that's, if there's such a thing, 'Stick free'. I'm really tired of sticking myself. I feel like a pin cushion.—Male patient with T2DM (age, 52 years)

If it was something like intranasally administered that would probably be a lot easier for other people.—Male patient with T1DM (age, 61 years)

I guess to not have to be so invasive with a needle, it would be nicer if you could do it nasally.—Male acquaintance with T1DM (age, 62 years)

### Overall Preference

After showing both options, study participants were asked which device they prefer overall. More participants across all subgroups preferred nasal glucagon (33 [73%]) versus autoinjector glucagon (12 [27%]). Table III reports the frequencies of comments about each device stratified by those preferring nasal glucagon and those preferring autoinjector glucagon. The most frequent reasons for preferring nasal glucagon included easier to use, absence of a needle, not needing to move or remove clothing to find an injection site, and others would be more comfortable with it:

I'd probably pick the nose spray, because it doesn't have to deal with a needle and it's pretty darn

Table II. Spontaneously identified aspirational device features (n = 45).

## Aspirational Feature (Frequency of Comment)\*

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Easy to use (n = 29 participants [64%])
Preprepared
Premixed (20)
A pen of some sort/hypodermic gun (5)
Easy to use/not complicated (8)
Can use quickly (6)
Can be injected anywhere on the body (2)
Easy to open (1)
Able to handle/use with one hand (1)
Don't have to read instructions (1)
Knowledge of location site to administer (1)
Machine-like guide to walk you through steps to use it (1)
Simple enough for a child to be able to use (1)
Easy to carry/small (n = 9 participants [20%])
No needle/no long needles (n = 8 participants [18%])
No long needles (5)
No needles at all/tired of sticking self (2)
Not so invasive as a needle (1)
Easy instructions (n = 4 participants [9%])
Simple bold step by step instructions (2)
Not an excessive amount of instructions (1)
Pictures on the pen (1)
Additional comments (n = 23 participants [51%])
Glucagon patch on skin (4)
Fast acting (3)
Nasal device (3)
Inhaler/like asthma inhaler (3)
No need to be refrigerated (3)
Automatic needle/less human control (2)
Long shelf-life (2)
Pump that would be able to sensor low glucose levels/pump glucagon (2)
Affordable (1)
Don't have to prepare injection site by cleaning hands/alcohol (1)
Don't have to get bubbles out before injection (1)
Needle that goes into the finger vs thigh or belly (1)
Not battery powered (1)
Simple to measure medication (1)
Something worn and could sensor and alert for low sugars (1)
Stays secured (1)
Withstand cold/water-proof/heat (1)

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\* Comments not mutually exclusive.

Table III. Frequency of spontaneous comments regarding most preferred device.

Comment	Preferred NG Over AI (n = 33)			Preferred AI Over NG (n = 12)		
	Patients (n = 10)	Caregivers (n = 13)	Acquaintances (n = 10)	Patients (n = 5)	Caregivers (n = 2)	Acquaintances (n = 5)
Easier to use	8	9	9	1		4
No need to remove clothes/finding site	6	8	5			
No needle/less invasive	3	6	8			
Other people more comfortable with it	6	4	5			
Faster to use/faster glucagon delivery	2	7	3		1	2
Easy to carry/small	5	3	3			
Intuitive/familiar	3	4		3	1	2
Easier for child to use	2	4	1	1		
Less embarrassed	3	1				
Feel secure/reassured			3	2		
Difficult to make mistake with it	2	1				4
Everything gets to where it needs to go		2		2	1	4
Can use on multiple bodily sites				3		3
Larger size/more manageable				1	1	3

AI = autoinjector glucagon; NG = nasal glucagon.

straightforward.—Male caregiver of patient with T1DM (age, 26 years)

It's easier to use, less chance of getting hurt, don't have to worry about the needles thing. If she's unconscious, I don't have to get through clothes and stuff to do it.— Male acquaintance of patient with T1DM (age, 56 years)

It's either slightly disrobing, which people would probably balk at, or giving it right through your pants or your dress or whatever it is that you're wearing. Some people may be a little bit squeamish about doing that.—Male patient with T1DM (age, 73 years)

In addition, participants indicated that the compact size of nasal glucagon was favorable, expressing that it would be easy to carry with them. In addition, they thought that it could be used quickly, with nasal delivery being easily accessible:

Fine. I would be more likely to carry that than the injectable thing...Number one [T1DM Patient, Male, Age 73]

It obviously looks pretty small and compact. It'd be very easy to take with us anywhere [T2DM Caregiver, Male, Age 38]

It's small enough where it's easy to carry. I would be able to easily get it and be able to do it. I think it's really quick. [T2DM Acquaintance, Male, Age 47]

I feel like the spray is a little bit more direct, as far as where it wants to go, how you can do it, things like that [T1DM Caregiver, Male, Age 24]

It looks like it's smaller. I'm thinking of a one-handed mechanism. It looks like you could pop it open with your teeth or pop it open with your thumb, to get at it. [T1DM Acquaintance, Female, Age 56]

Those who favored autoinjector glucagon indicated that it appeared to be easier to use, was more intuitive and familiar, and could be used on multiple body sites:

I think that it is intuitive when people think of diabetes, they think of blood and needles, so I think that they would automatically know what to do [T2DM Patient, Female, Age 48]

The first reason, because I'd get used to the auto-injector, so I use it all the time for my husband, the insulin, how to put it in the skin and how to deal with it. The second reason would be because I think it's going to be faster on the skin [T2DM Caregiver, Female, Age 34]

Because it's like one milligram, and you can put it on more than one part of your body, your arm, your leg or stomach [T2DM Patient, Female, Age 50]

Some who favored autoinjector glucagon indicated that they felt confident that the full dose would be delivered with this device:

But if I had my preference on the two the auto-injector seems a little more foolproof to me that you're actually doing it correctly and that everything's getting where it needs to go.—Female acquaintance of patient with T1DM (age, 51 years)

I think that to me, the autoinjector would be much easier to inject into a person... I know that the medicine is in both of them, but with the auto-injector, if you inject it in, you know it all went in. There's nowhere for it to go.—Female acquaintance of patient with T1DM (age, 42 years)

**Feeling Prepared and Protected**

Participants described feeling prepared in terms of knowing exactly what to do, when to do it, where to do it, and being ready in case of a severe hypoglycemic episode. Being prepared included

**Table IV. Which device makes someone feel more prepared? (n = 38\*).**

(Frequency of Comment)<sup>†</sup>

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NG better than AI (n = 19 participants [50%])

- Patients (n = 6)
  - Don't have to find injection spot on body (3)
  - Easier for someone not comfortable with needles/injections (2)
  - Smaller so more likely to have it with me (1)
  - Reason not provided (2)
- Caregivers (n = 7)
  - Faster to administer (5)
  - Have had malfunctioning AIs in the past (1)
  - Easier to administer (1)
- Acquaintances (n = 6)
  - Don't have to find injection spot on body (2)
  - Feel more prepared with nasal delivery (2)
  - Easier to use/more confident with it (1)
  - Faster to administer (1)
  - Don't have to make sure it/needle goes in straight (1)

AI better than NG (n = 9 participants [24%])

- Patients (n = 3)
  - If patient has cold/nose might be stuffed up/not work (1)
  - More difficulty administering in nose/also device could get stuck (1)
  - Reason not provided (1)
- Caregivers (n = 2)
  - AI more familiar/has needle vs nasal spray (1)
  - Reason not provided (1)
- Acquaintances (n = 4)
  - More familiar with it/more comfortable with it (2)
  - Easier to use (1)
  - More apparent that it is rescue medication (1)

Both devices the same (n = 10 participants [26%])

AI = autoinjector glucagon; NG=nasal glucagon.  
 \*Seven participants were not asked.  
<sup>†</sup>Comments not mutually exclusive.

having something on hand that is quick and easy to use in case of an emergency:

Having something on hand and knowing that, if we got to that position, I had something to be fixing it or helping it until help came. Right now, I don't feel prepared with just cake gel.—Female caregiver of patient with T1DM (age, 40 years)

Some participants also noted that feeling prepared means not being nervous or feeling less stressed and knowing that they had something to help if necessary:

That I'm not worried about taking trips and things and worried about if something happens.—Male patient with T1DM (age, 61 years)

Feeling confident and knowing that this is the best thing you can do to try to get him out of it.—Female caregiver of patient with T2DM (age, 55 years)

Among 38 participants who compared the 2 devices with respect to feeling prepared, more participants across all subgroups reported that nasal glucagon seemed better (19 [50%]) than autoinjector glucagon (9 [24%]); 10 (26%) reported no difference (Table IV). Reasons for why participants believed that they would be more prepared with nasal glucagon included not having to search for an injection site on the body, being able to use it more quickly, and others being more comfortable with it:

The nasal has more immediacy... Let's say it did happen and I could pull that spray out, take it out, prepare it, utilize it within 10 or 15 seconds.—Male caregiver of patient with T1DM (age, 38 years)

With the nasal, you don't have to find a spot on the body.—Male acquaintance of patient with T1DM (age, 66 years)

Reasons for stating that the autoinjector glucagon would be better included that there may be difficulty with administering glucagon through the nose and

Table V. Would you or others hesitate to use device? (n = 35)<sup>a</sup>.

(Frequency of Comment) <sup>†</sup>
NG better than AI (n = 18 [51%])
Patients (n = 6)
People are scared of needles/hurting patient (6)
Less confident that you are injecting right part of body with AI (1)
Caregivers (n = 6)
Fearful/scared of needles/injections (4)
Determining injection site (1)
Holding down and pushing/stabbing with needle (1)
With needle more worried about doing something wrong, getting sued (1)
Acquaintances (n = 6)
Don't have to look for/situate someone to inject (3)
Using a needle might bother someone/cause hesitation (3)
AI better than NG (n = 6 [17%])
Patients (n = 1)
Another person might not be able to put NG up nose properly (1)
Caregivers (n = 3)
NG need to read instructions/concentrate more on how to use it (2)
Nostrils closed because of stuffiness/will medication get through (1)
Acquaintances (n = 2)
Familiar with a pen vs NG (2)
Both devices the same (n = 11 [31%])

AI = autoinjector glucagon; NG = nasal glucagon.

<sup>a</sup>Ten participants not asked.

<sup>†</sup>Comments not mutually exclusive.

that the autoinjector glucagon was a more familiar rescue device:

I would feel more prepared with the auto injector because my background with the EpiPen. So I feel like I could pretty easily get this one.—Male

acquaintance of patient with T2DM (age, 18 years)

Participants described feeling protected in terms of being able to depend on or trust that the medication would work for them, trusting that a random stranger could assist them, being safer or more secure, not getting hurt, and being able to make it through a possible life or death situation:

If I'm in this situation, do I feel like it would work?—Male caregiver of patient with T1DM (age, 24 years)

Feeling more secure.—Male acquaintance of patient with T2DM (age, 37 years)

Several indicated that being protected in the situation of severe hypoglycemia is similar to feeling prepared:

Being protected is just another way of saying being prepared.—Female caregiver of patient with T1DM (age, 40 years)

### **Hesitation With Device**

Thirty-five participants responded to a question about which device would more likely lead to hesitation in use. More participants across all subgroups reported that nasal glucagon seemed like it would involve less hesitation (18 [51%]) versus autoinjector glucagon (6 [17%]); 11 (31%) reported that they appeared to be the same (Table V). Reasons for nasal glucagon causing less hesitation included that people are likely to be more anxious or fearful of needles and needing to locate and determine an injection site with the autoinjector glucagon:

They may be hesitant to use the auto-injector because it's got the needle, and they probably don't want to hurt you.—Female patient with T2DM (age, 51 years)

Some people are squeamish with needles so they might hesitate more with the needle....and you might

not be as confident that you're hitting the right part of the body when you're injecting. Whereas the nasal you have your choice of 1 of 2 nostrils. You can't miss that.—Male patient with T1DM (age, 61 years)

Reasons given for why the autoinjector glucagon appeared to be better included people being more familiar with an autoinjector device; with nasal glucagon, there would be a need to read the instructions and concentrate more:

I think you need to concentrate more to get used to using it. Like concentrate and have more confidence in how to use it.—Female caregiver of patient with T2DM (age, 34 years)

I'd say people are understanding more with the needle.—Female acquaintance of patient with T1DM (age, 56 years)

### **Glucagon Administration in Children**

In general, participants believed that either nasal glucagon or autoinjector glucagon could easily be used on children. Some participants reported that, with nasal glucagon, the absence of the needle would make administering glucagon to children correctly easier to do. Some participants also suggested that it would be easier for children to administer glucagon using nasal glucagon on someone in case of an emergency.

I think this would be so much easier. It sounds like it would be a lot less traumatic. There's not a needle involved...—Female caregiver of patient with T1DM (age, 34 years)

I don't think I would have a problem using this on a child versus an adult. It does seem a whole lot easier than having a needle involved.—Male caregiver of patient with T1DM (age, 40 years)

Those that suggested it would be easier to use autoinjector glucagon with a child indicated that children may not want something delivered through

the nose or it may be difficult to administer glucagon correctly with nasal glucagon if a child is seizing, wriggling, or moving around:

They'd probably have more issues for you trying to put something in their nose.—Male acquaintance of patient with T1DM (age, 52 years)

Depending on their movements. It can be used, but it just seems like it could be slightly more difficult than other methods.—Male caregiver of patient with [T1DM (age, 40 years)

### Use in Public

Participants described that they would feel more comfortable socially with nasal glucagon, indicating that it was less conspicuous and less embarrassing and that others get more anxious around a needle:

It's smaller. It looks like it's about the size of a tube of Chapstick.—Female caregiver of patient with T1DM (age, 34 years)

Needles imply a very serious situation. Some might be a little more level headed if they only knew they had to apply the nose spray, versus injecting somebody.—Male caregiver of patient with T1DM (age, 26 years)

People get a little bit more anxious with the needle.—Male acquaintance of patient with T2DM (age, 18 years)

I think there's something about needles that freaks people out. Even though there are a lot of people who seem to have EpiPens, and this would be similar, I still think there'd be a lot of people that wouldn't be willing to administer someone a shot at a grocery store. A friend, yes, but a random person, no.—Female caregiver of patient with T1DM (age, 34 years)

Given the favorable profile of nasal glucagon, including it being compact and having a common mode of administration, participants indicated that it would be more discreet and socially desirable to have and to use in public. Of 35 participants asked, more

indicated that they would be less embarrassed with the use of nasal glucagon versus autoinjector glucagon (16 [46%] vs 4 [11%]); 15 (43%) felt that there would be no difference between the devices:

With the spray I would feel more confident. It's more discreet and it goes direct. I feel like with the pen, I would feel awkward and weird.—Male caregiver of patient with T1DM (age, 24 years)

Definitely this [nasal glucagon] would be inconspicuous. It would be less embarrassing. It would be less of a hassle to have to put together.—Male caregiver of patient with T1DM (age, 40 years)

In general, participants said that they would tell others about having either device with them when they were out with friends or acquaintances. With respect to being able to teach others how to use the devices, reasons for favoring nasal glucagon included that people generally are more nervous about needles and they would not have to search for an injection site on the body:

I think it might bother other people injecting someone. A nose spray, non-invasive, very easy.—Male caregiver of patient with T1DM (age, 26 years)

You can't go wrong. It's for the nose and only for the nose. There's no searching for a specific part of your body. It's a quick thing.—Male patient with T2DM (age, 52 years)

For the person's privacy or whatever, all the areas that need to be exposed are the areas that you usually try to keep covered, in other instances.—Female acquaintance of patient with T2DM (age, 56 years)

A key reason for perceiving that others may favor the autoinjector glucagon when out in public was its familiarity and that there were multiple options on where to inject glucagon. In addition, it would be particularly familiar if an acquaintance or stranger had diabetes.

You can put it on more than one part of your body.—Female patient with T2DM (age, 50 years)

It's easy. I know how to use it before.—Female caregiver of patient with T2DM (age, 34 years)

But if they were a diabetic, they'd be like, 'No. Let me go with the needle'.—Female patient with T1DM (age, 49 years)

## DISCUSSION

This research identified key factors that influence attitudes toward glucagon delivery devices, highlighting that people with diabetes and their caregivers and acquaintances would like a device that is simple and ready to use. The participants in this study indicated that having such a device would make them feel more prepared and protected in the case of a severe hypoglycemia emergency. The patients and caregivers indicated that they would tell others about the device if they had it. A device that administers glucagon via the nose was perceived to have a number of advantages over an autoinjector device, primarily because it was viewed as less complicated to use and avoids a needle injection.

As potential end-users of glucagon delivery systems, this research incorporated the perspectives of both caregivers of patients with diabetes as well as acquaintances. Consistent with previous studies examining preferences for features of insulin pen devices that included both patients with diabetes and caregivers, this study found that ease of use is a key attribute that influences preferences.<sup>27,28</sup> A device that is easy to use is likely to be associated with fewer errors in administration. Indeed, one study found that >94% of caregivers and 93% of acquaintances delivered full doses of nasal glucagon, whereas only 13% of caregivers and 0% of acquaintances delivered full doses of the existing injectable glucagon.<sup>14</sup> As observed in asthma, inhaler errors are common; thus, it is important to focus on ease of use in inhaler device development.<sup>29</sup> Optimizing existing therapy delivery or switching to a suitable alternative can help avoid unnecessary escalation of treatment and health care resources.<sup>30</sup>

Preference to carry the device is especially important for patients with diabetes taking insulin for whom severe hypoglycemic episodes are unpredictable. A recently developed diabetes injection device preference questionnaire includes being able to carry the device when away from home,<sup>31</sup> which was identified as an important feature of a glucagon delivery device in this study. Device size and carrying around the device were features included in a previous study that compared preferences for the epinephrine autoinjector (EpiPen) versus a smaller new epinephrine autoinjector (Auvi-Q) that provides audio and visual cues for patients at risk for life-threatening allergic reactions.<sup>28</sup> The findings indicate that, for experienced and inexperienced participants in all 3 participant subgroups (adults, caregivers, and children), Auvi-Q was preferred over EpiPen for instructions, preference to carry, and device size. Given the finding in this study that patients with diabetes and caregivers perceived that the new devices would be easy to carry, this could lead to less medical resource use associated with severe hypoglycemic episodes if these devices were available.

A strong preference for nasal glucagon was indicated, given its lack of needle and uncomplicated glucagon delivery process. Preference for nasal glucagon was emphasized in a public setting, where it may be more embarrassing and more intrusive to use the autoinjector. Study participants noted that caregivers or acquaintances may hesitate in administering glucagon with autoinjector glucagon because the needle may make them nervous and also involves locating an injection site. Fewer steps in administration have previously been found to translate into stronger preferences, with patients with asthma placing the most value on an inhaler that requires one step versus multiple steps for dose preparation.<sup>32</sup> Nevertheless, some participants had concerns with nasal glucagon, particularly because they perceived that nasal delivery may not be as reliable a delivery method as an autoinjector. In addition, familiarity with needle injections increased the likelihood that the autoinjector would be preferred. Given that familiarity with the respective devices was a key factor that influence preference, future quantitative studies exploring device perceptions should examine the effect of familiarity on preferences.

Study limitations include that participants saw only visuals of the draft instructions for use for nasal glucagon and autoinjector glucagon; they did not handle the devices that are in development. As such, it is possible that perceptions of the actual devices could differ with device experience. Nevertheless, the devices incorporate several features that were spontaneously elicited about an ideal device before participants were introduced to the 2 products in development. Solely focusing on adults and not including children in this research is another limitation. However, we were primarily interested in understanding the perspectives of adults who likely would be involved in device selection in the future.

In addition, given that thorough details about each device were not presented, some participants made erroneous assumptions that may have influenced their perceptions. For example, a few participants believed that nasal glucagon could not be used if an individual had a stuffy nose from a cold, which is not accurate. The objective of this research was solely to compare the 2 medication delivery devices, nasal glucagon and autoinjector glucagon, both of which are noninferior to glucagon injection in clinical trials.<sup>33,34</sup> The glucagon contained within both devices is assumed to be similar. Costs were not included because these are not yet available for the 2 devices because they still are in development. Nevertheless, even if costs were available, they may have confounded the results. Moreover, adding costs would pose a significant challenge in interpretation given the many possible permutations and combinations for cost-sharing, copay, and coinsurance in the United States.

This research represents the initial concept elicitation step recommended for new instrument development. The feedback from potential users of glucagon delivery devices provided a rich set of information and will be used to inform the development of a survey to assess attitudes toward delivery devices. As such, the new measure will capture the voice of future potential device users and will be comprehensive in assessing key factors associated with preference. In addition, the inclusion of patient feedback is consistent with the American Diabetes Association guidelines on patient management, which recommend that treatment goals and plans be created with the patients based on their individual preferences, values, and goals.<sup>23</sup>

## CONCLUSION

In conclusion, the sample of patients with diabetes, caregivers, and acquaintances in this study expressed a desire for an easy-to-use glucagon delivery device that can conveniently be carried outside the home. On the basis of the qualitative feedback obtained, the introduction of the nasal glucagon and autoinjector glucagon devices will represent substantial progress in meeting this need. This study yielded key features that are influential in patient, caregiver, and acquaintance perspectives of glucagon delivery devices. Driving factors that influence preference for nasal glucagon over autoinjector glucagon included that it appeared to be easy to use, not as invasive as a needle, and quicker to use and that other people likely would be more comfortable with it. A benefit of such a device is that individuals likely would feel more prepared and protected in the case of an unpredictable severe hypoglycemic event. The influential features as well as their perceived effects identified in this study should be incorporated into future quantitative studies assessing attitudes toward nasal and autoinjector glucagon delivery systems.

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**APPENDIX A. SUPPLEMENTARY DATA**

The following is the Supplementary data to this article:

**Qualitative Research Caregiver/Acquaintance****Discussion Guide**

Severe Hypoglycemia Study  
Caregiver/Acquaintance Qualitative Discussion  
Guide

**Research objectives:**

- To understand perceptions about glucagon delivery and potential impacts of different delivery devices for severe hypoglycemia among patients with T1 or T2 diabetes on insulin.
- To identify concepts for incorporation into a new questionnaire assessing glucagon delivery devices.

**I. Background and experience with hypoglycemic (low blood sugar) episodes (15 minutes)**

1. Please start by telling me a little bit about yourself, like your age and ...
  - a. Who do you live with?
2. Do you take care of someone, or do you have a friend or acquaintance who has diabetes?
  - a. Please tell me about this person.
    - i. How old are they?
    - ii. How often do you see this person?
  - b. How many people do you take care of or know who have diabetes?
3. Do you know what severe hypoglycemia is?
  - a. What do you understand about severe hypoglycemia?
  - b. How did you first learn or hear about it?
4. Have you ever administered any rescue medications (for example, epinephrine, glucagon, narcan, or seizure medications)?

*[Provide Severe Hypoglycemia Stimuli]*

*[describe glucagon] Glucagon is a hormone that works to control glucose levels in the blood, and can be used to treat severe hypoglycemia.*

5. Have you ever heard about glucagon before this interview? Have you ever delivered a glucagon injection in the case of a severe hypoglycemic episode?

6. Do you have concerns about [your child/your friend] having a severe hypoglycemic episode where they lose consciousness or cannot help themselves?
  - a. How ready do you feel you are if your friend/acquaintance has a severe hypoglycemic episode tomorrow?
7. Overall, do you have a general fear of medical devices?
8. Have you ever helped someone experiencing a severe hypoglycemic episode where they lost consciousness or could not help themselves.
 

*(if Yes)*

  - a. How did you know it was happening?
  - b. What steps did you take?
  - c. Did you call for medical assistance? If so, when (Probe if applicable: before/after administering glucagon)?
  - d. How were you feeling?

*(If No)*

  - e. What do you think you would do if your child/friend/acquaintance had a severe hypoglycemic episode where they lost consciousness or could not help themselves?
  - f. Do you think you would try to treat the person?
9. How often have you observed someone experiencing hypoglycemia (x times/week, /month/year)?
  - a. How often have you seen someone having a severe hypoglycemic episode where they lose consciousness or cannot help themselves?

**II. Glucagon delivery devices (20 minutes)**

10. Please imagine that a new device for delivering glucagon is being developed. What types of features do you think would be useful for a new device?
  - a. Please imagine there is a new device where glucagon is administered as a spray through the nose?
  - b. What do you think would be the advantages of such a device?
  - c. What would be the drawbacks?
    - i. *If mentions not as effective:* Assuming the same effectiveness as the current device?

11. Please imagine there is a new device where glucagon is administered by an injection using an autoinjector device?

- a. What do you think would be the advantages of such a device?
- b. What would be the drawbacks?

Today we will be discussing 2 devices for delivering glucagon: a nasal glucagon device /and a autoinjector glucagon device.\*

*\* The images of nasal glucagon and autoinjector glucagon will be shown side by side\**

*\*\* The instructions for nasal glucagon and autoinjector glucagon will be seen on share screen in random order with each successive interview\*\* (20 minutes)*

First, I am going to show instructions for a new glucagon delivery device called [nasal glucagon or autoinjector glucagon] Give respondent few minutes to read instructions.

For each set of device instructions:

12. What are your thoughts about this device?
13. How would you feel if someone had this device when they were experiencing a severe hypoglycemic episode?
14. How would you react if someone had this device in such a situation?
  - a. What do you think about the instructions?
  - b. Are they easy or difficult to follow?
    - i. What makes them easy or difficult?
- c. How likely would you be to follow the instructions to deliver glucagon if someone were having a severe hypoglycemic episode?
- d. Would you need additional training on the instructions?
- e. How easy or difficult would it be to prepare this device for use in a stressful rescue situation?
- f. Do you think you would call 911 instead of using this device? Call 911 and use this device? Not call 911 and just use this device?
- g. How likely do you think you would be to use this glucagon delivery device correctly in a rescue situation?

h. How confident are you that the correct dose would be administered?

- i. (patient/caregiver) How confident are you that this device would be used correctly at home? (all outside of the home like at an office or school?
  - j. How confident are you that this device would be used correctly with children having an episode? With adults?
15. Would you be fearful or anxious about anything if someone had this device in their emergency kit, and they were having a severe hypoglycemic episode?
- a. Would you be fearful of getting hurt with this device?
  - b. Would you fear hurting someone having a severe hypoglycemic episode with this device?
  - c. What are your thoughts about possibly mixing up recognizing the correct device versus an insulin pen?
  - d. How easy or difficult would it be for you to prepare the individual when using this device?
  - e. How easy or difficult would it be to find a location on the body for delivering glucagon with this device?

16. Overall how much do you think you would like or dislike this device?
- a. How satisfied or dissatisfied do you think you would be with this device?

*\* \* After the two sets of questions have been asked about each device \* \* (20 minutes)*

17. In thinking about the two devices, are there differences that are important in your opinion?
- a. Is one device more complicated to administer than the other?
  - b. Would you feel more prepared with one versus the other?
  - c. Would be you feel that someone with diabetes would be more protected with one versus the other?
  - d. What about each of the devices could cause you to pause or hesitate in using it?
    - i. Do you think that you would pause for longer or hesitate in knowing what to do to deliver glucagon using one versus the other?
    - ii. Would you hesitate in finding a location for delivering the treatment for each device?

- e. Would you be more likely to use one of these devices versus the other?
- f. Do you think you would be less likely to call 911 before delivering glucagon with one device versus the other?
- g. Would you have more fear in using one device versus the other?
  - h. Is a nasal spray or injection easier to administer?
    - i. Do you prefer a nasal spray or a needle injection?
18. What do you think about needles? Do you like or dislike them?
  - a. Do you fear them?
  - b. What about giving someone an injection? How do you feel about this?
19. What about a nasal spray? Do you fear this?
20. Which device would you prefer for administering to a child?
  - a. Would you be more likely to recommend one over the other to you friend or loved one who has diabetes?
  - b. Would other caregivers taught to use glucagon rescue products prefer to use one of these devices over the other? (caregivers)
  - c. If you had either of these devices, would you tell people about it so that they could potentially administer in a rescue situation outside of the home? How many?
  - d. Would you tell more people about one of the devices versus the other? How many more people?
  - e. Would you have more confidence in asking acquaintances for help in a severe hypoglycemic episode with one device versus the other?
21. In thinking about the two devices, which would you prefer?
  - a. What about [insert preferred device] makes it more preferred?

*probe if not raised:*

  - b. Is this device easier to learn?
  - c. Is this device less intimidating? Is it more intuitive without requiring additional training beyond the instructions?
  - d. Are you more confident that you would use it correctly?
  - e. Do you think it is easier to use in a stressful situation?
  - f. Do you think it takes less time to prepare? (caregivers):
    - i. Is it easier to carry around? Easier to store?
    - ii. Would you be more likely to carry this device outside of the home?
    - iii. Would your child/loved one be more likely to carry it?
    - iv. Would you feel more comfortable having this device on hand in a rescue situation?
    - v. What about feeling more comfortable socially?
    - vi. Would you be less nervous about someone using this device successfully?
    - vii. Would you be less nervous that someone may confuse this device with the insulin device?
    - viii. Would you be less embarrassed for your child with the use of this device?
    - ix. What about feeling like a failure in public? Or feeling shame for your child/loved one?
22. Is it easier to use overall?
23. Would you be more likely to purchase this device versus the other?

Thank you so much for your time and feedback.  
**Total time: 60 minutes**

**Qualitative Research Patient Discussion Guide**  
 Severe Hypoglycemia Study  
 Patient Qualitative Discussion Guide

**Research objectives:**

- To understand perceptions about glucagon delivery and potential impacts of different delivery devices for severe hypoglycemia among caregivers and acquaintances of patients with diabetes.
- To identify concepts for incorporation into a new measure assessing glucagon delivery devices.

**I. Background and experience with hypoglycemic (low blood sugar) episodes (10 minutes)**

1. Please start by telling me a little bit about yourself, like your age and ...
  - a. How long have you had diabetes (Type 1/II)?
  - b. What type of insulin do you use (such as diabetes pills or oral medication, insulin injections, or an insulin pump)
    - If not sure, do you take it once a day only or at mealtimes both?

- c. Have you ever administered any rescue medications (for example, epinephrine, glucagon, naran, or seizure medications)?
- 2. Do you know what severe hypoglycemia, or very low blood sugar requiring assistance from someone else, is? What do you understand about it?
  - a. How did you first learn or hear about it?
  - b. Did your doctor discuss it with you?

*[Provide Severe Hypoglycemia Stimuli]*

*[Describe Glucagon] Glucagon is a hormone that works to control glucose levels in the blood, and can be used to treat a severe hypoglycemia episode.*

- 4. *Have you ever had a severe hypoglycemic episode where you are unable to help yourself? (if yes)*
  - c. When did it last happen?
  - d. How often has it happened in the past 5 years?
  - e. How many times has it happened at home and/or outside of the home in the past 5 years?
- 3. Please can you describe any concerns you may have about having a severe hypoglycemic episode?
  - a. Do you think it will happen to you in the future?
  - b. Do you feel ready for it if it happens?

## II. Glucagon delivery devices (7 minutes)

- 4. Do you have a means for delivering glucagon [not insulin] in case a severe hypoglycemia episode occurs?
  - a. Do you carry it around with you? When?
  - b. How do you feel having this with you when you go out?
    - i. How many individuals have you told about your glucagon device?
    - ii. With how many have you explained its instructions?
- 5. Please imagine that a new device for delivering glucagon is being developed. What types of features would you want with this new device?
  - a. *(if already have glucagon device)* What are features that would make you want to choose the new device over the one you have?

- 6. Would you have interest in a device where glucagon is administered as a spray through your nose?
  - a. What do you think would be the advantages of such a device?
  - b. What would be the drawbacks?
    - i *If mentions not as effective:* Assuming the same effectiveness as the current device?
- 7. Would you have interest in a device where you take glucagon as an injection using an autoinjector device?
  - a. What do you think would be the advantages of such a device?
  - b. What would be the drawbacks?
- 8. Today we will be discussing 2 devices for delivering glucagon: a nasal glucagon device /and a autoinjector glucagon device.\*

\*\* The screen will show the two images side by side\*\*

*\*\*instructions for nasal glucagon and autoinjector glucagon will be seen on share screen in random order with each successive interview\*\* (20 minutes)*

First, I am going to show instructions for a new glucagon delivery device called [nasal glucagon or autoinjector glucagon]. Give respondent few minutes to read instructions.

*For each device:*

- 9. What are your thoughts about this device?
  - a. How would you feel about having this device with you?
  - b. What are your thoughts about carrying this device around with you?
    - i How easy or difficult would be to carry around this device?
    - ii How easy or difficult would it be to store this device?
  - c. What do you think about the instructions?
    - i Are they easy or difficult to follow?
    - ii What makes them easy or difficult?
  - d. How likely is it that someone who has not been taught before would be able to follow

the instructions to give you glucagon if you were having a severe hypoglycemic episode?

- i What about someone who you taught before; how likely would they be able to follow the instructions if a severe hypoglycemic episode occurred?
- 10. What do you think about the potential time it may take to use this device?
- 11 How do you think someone would react if you had this device and were experiencing a severe hypoglycemic event?
  - a. How likely do you think it is that someone would use this device correctly in an emergency situation?
    - i. Do you think someone would call 911 instead of using this device?
- 12. What are your thoughts about someone using this device on you?
- 13 Would you be fearful or anxious about someone using this device on you?
  - a. Would you be fearful of getting hurt with this device?
  - b. How easy or difficult would it be for someone to prepare you when using this device?
  - c. How easy or difficult would it be for someone to find a location on your body to deliver the medication?
  - d. How nervous would you be about someone being able to use this device successfully?
- 14 Overall how much do you think you would like or dislike this device?
  - a. How satisfied or dissatisfied do you think you would be with this device?

**\* \* After the two sets of questions have been asked about each device \* \* (20 minutes)**

- 15. In thinking about the two devices, what differences are important in your opinion?
  - a. Overall, which is easier to use in a stressful situation?
  - b. Would you feel more prepared for someone to deliver glucagon using one device versus the other?
  - c. Would you feel more protected with one versus the other? Would you feel more safe with one versus the other?

- 16. What in your opinion does it mean to feel prepared with the availability of these devices?
  - a. Do you think that an acquaintance would hesitate more in using one versus the other? If so, what about the device would cause them to do this?
  - b. Do you think that your spouse or closest friend would hesitate more in using one versus the other? If so, what about the device would cause them to do this?
  - c. Is it easier to teach someone to use one device versus the other?
  - d. How many individuals would you tell about each glucagon device if you had it? Would you tell more about one versus the other? How many more?
    - i *If applicable:* Would you explain the glucagon device to more people compared to the one you have now?
- 17. In thinking about the two devices, which would you prefer? What about [insert preferred device] makes it more preferred?
 

*Probe if not raised*

  - a. Which would you prefer to be used on you?
  - b. Are you more confident that it would be used correctly, according to the instructions?
  - c. Are you more confident that it would be used correctly in a rescue situation at home? Outside of the home?
  - d. Are you more confident that it would be used correctly in a rescue situation for a child? For an adult?
  - e. Would you be more confident in the ability to deliver the correct dose with this device versus the other?
  - f. What about the ability to deliver a complete dose?
  - g. Is it easier to learn? Is it more intuitive and straightforward requiring no additional training beyond the instructions?
  - h. Do you think it is easier to prepare?
    - i. Do you think it takes less time to prepare?
    - j. Is this device less intimidating than the other?
  - k. Do you prefer the method of delivering glucagon (nasal spray or a needle injection)?
    - l. Is it easier to administer a nasal spray or a needle injection?

18. What do you think about needle injections?
  - a. Do you like or dislike them?
  - b. Do you fear them?
  - c. Would you be concerned that someone may confuse your insulin injection device with the glucagon device?
19. What about a nasal spray?
  - a. Is it easier to carry around?
  - b. Would you physically be more comfortable carrying this device around?
  - c. Would you feel more comfortable socially carry this device around?
  - d. How likely would you be to purchase this device?
  - e. How likely would you be to carry this device for non-home severe hypoglycemic episodes?
  - f. How often would you carry it with you?
  - g. Which would you most prefer to use at home?
20. Would you have more confidence in asking acquaintances for help in severe hypoglycemia with this device versus the other?
  - a. Would you be more likely to teach the use of this device to your extended family and friends?
  - b. Would you be less embarrassed with the use of this device?
    - i. Probe on potentially feeling less of a failure in public or less shame with one device versus the other?
  - c. Is it more convenient overall?
21. Which device would your family, friends, and/or colleagues prefer to use? Why

Thank you so much for your time and feedback.

**Total time: 60 minutes**