SHORT ORAL DISCUSSION – PRESENTATION 1080

A qualitative study to understand providers' perspectives on hyperketonemia, diabetic ketoacidosis healthcare burden and ketone monitoring in type 1 and type 2 diabetes care.

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Ketone monitoring is essential for DKA prevention

- DKA is a life-threatening acute complication of diabetes, especially for people living with diabetes who are insulin-dependent[1,2]
- Ketone monitoring is important for the early detection of hyperketonemia and prevention of DKA[1]
- However, previous research has identified barriers to ketone monitoring, and the rate of appropriate monitoring, especially among adults, is low[1,3]

DKA, diabetic ketoacidosis

1. Umpierrez GE *et al.* Diabetologia 2024;67:1455-1479. 2. Wysham C *et al.* Diabetes Obes Metab 2025;27:2750-2767. 3. Albanese-O'Neill A *et al.* Diabetes Care 2017;40:e38-e39

Introduction

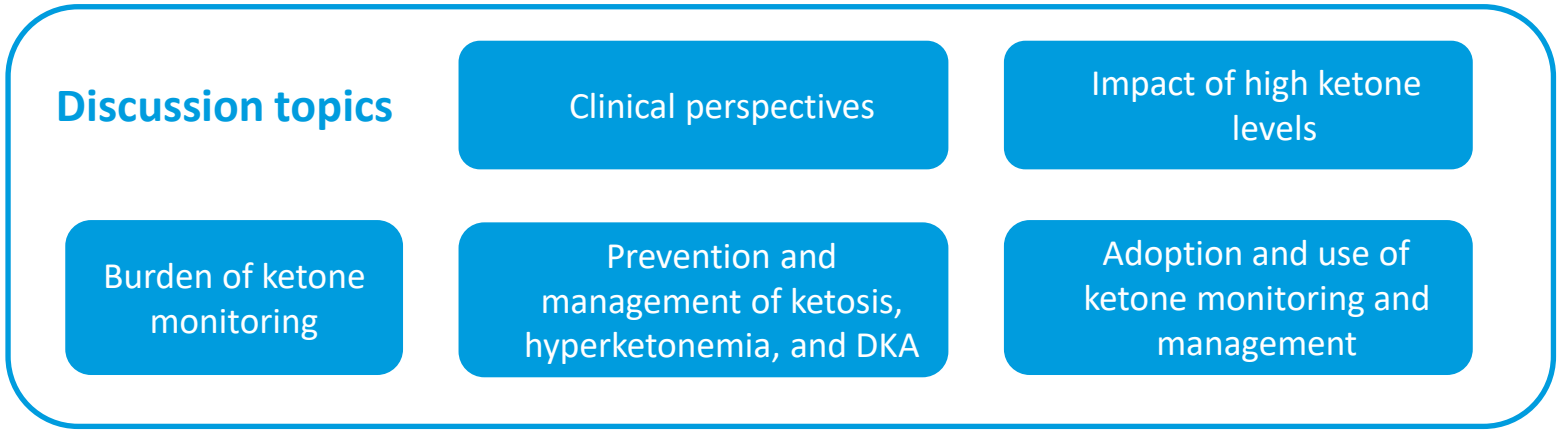
OBJECTIVE

To understand and explore provider perspectives on ketone monitoring, the management of ketone levels, and the impact of ketosis, hyperketonemia, and DKA among people living with diabetes

- This study investigated clinical perspectives on ketone management and monitoring, as part of a large mixed-methods study

Methods

- Qualitative, semi-structured interviews with healthcare providers
  - Endocrinologists, pediatric/child endocrinologists, or PCPs
- Participants were recruited through the T1D Exchange Registry and a survey vendor



DKA, diabetic ketoacidosis; T1D, type 1 diabetes

Results: Providers

- In total, 16 interviews were conducted, split between endocrinologists and PCPs

Characteristic	Full Sample (N = 16)
Provider type, n (%)	
Endocrinologist	8 (5 adult, 3 pediatric)
PCP	8
Age, years, mean (SD)	51.6 (8.6) [Min–Max: 38–72]
Female, n (%)	7 (44)
Number of years practicing post residency, mean (SD)	19.5 (6.5) [Min–Max: 9–33]
% of time spent providing direct care to people living with T1D/T2D (mean, SD)	43.3 (28.3) [Min–Max: 8–80]
Census region, n (%)	
Midwest	8 (50)
Northeast	1 (6)
South	5 (31)
West	2 (13)

PCP, primary care physician; SD, standard deviation; T1D, type 1 diabetes; T2D, type 2 diabetes

Guidance on ketone testing is often lacking, and ketone testing is inconvenient for patients

- Providers report different approaches for T1D vs. T2D
  - Providers emphasize ketone checks for T1D, while T2D monitoring is more selective
  - Management during illness is especially important
- Providers report that tools and confidence vary:
  - People with diabetes generally favor urine ketone strips
  - Although blood testing is more accurate, it involves a finger stick
- Providers report that guidance on elevated levels is needed
  - If people with diabetes have elevated ketone levels, metabolic tests and escalation of care may be needed
  - If a person with diabetes is progressing toward DKA, emergency care is necessary

"Any type of infection, whether it be under the weather, I think we've maybe have had people check a little bit. ***We have some pretty athletic people too****, so those who do marathon training and things like that and we have them keep an eye on it a little bit."*

HCP3, Endocrinology, Northeast

"Well, you can certainly check ketones in the urine, which is a plus minus thing; it's not terribly valuable. ***The more valuable is to actually check blood ketone levels****, and that would be, as I said, conjunction with other metabolic tests."*

HCP9, Internal Medicine, South

CGM, continuous glucose monitoring; DKA, diabetic ketoacidosis; HCP, healthcare provider; T1D, type 1 diabetes; T2D, type 2 diabetes

Preventing ketone accumulation relies on diabetes self-management – education is fundamental

- Providers reported that major drivers of DKA risk are:
  - Suboptimal diabetes management
  - Physical and functional status
  - Limited diabetes education
  - Certain medications (e.g., SGLT2i)
  - Certain behaviours (e,g. alcohol consumption)
- Providers emphasized that for people with diabetes hydration, glucose monitoring, and not missing insulin are the most important factors in avoiding DKA
- Education around ketone monitoring is foundational
- Providers reported that clinics benefit from standardized responses to ketone readings

> *"Those **people that are poorly controlled** are often not watching their sugars so they're not gonna be looking for ketones either"*
>
> **HCP10, Internal Medicine, South**

> *"I think that we make sure that we have patients on sensors. I'd say about **98 percent of our practice is on a sensor**…. **I think that's the easiest way to prevent [ketone accumulation], is making sure everyone's always aware of their glucose**"*
>
> **HCP17, Pediatric Endocrinology, Midwest**

> *"The **main thing is education**, right? Again, I know I give education, but I wish—and I try to refer them to a long session, hours of education. **The grand majority cannot afford it, so they deal with what I give them**"*
>
> **HCP6, Endocrinology, South**

DKA, diabetic ketoacidosis; HCP, healthcare provider; SGLT2i, Sodium-glucose cotransporter-2 inhibitor

People with diabetes are typically responsible for monitoring and recording their ketone levels, but data are not used consistently

- Ketone management is currently limited in many practices
  - Clinicians need to rely on people with diabetes to keep records of ketone levels
- Providers reported barriers for people with diabetes :

Financial (co-payments, reimbursement)	Emotional barriers (embarrassment, fear)	Logistical (supply or dexterity/cognitive issues)

- Most providers viewed ketone monitoring as a triage tool
  - Monitoring can help determine urgency and guide treatment
- Ketone monitoring is not used consistently across providers
  - Some clinicians rely more heavily on CGM trends

> *"Sometimes,* ***we're just relying on patients…. The parents are pretty good about remembering a good amount of stuff, but I don't blame them if they can't remember every single thing"***
>
> **HCP5, Pediatric Endocrinology, Midwest**

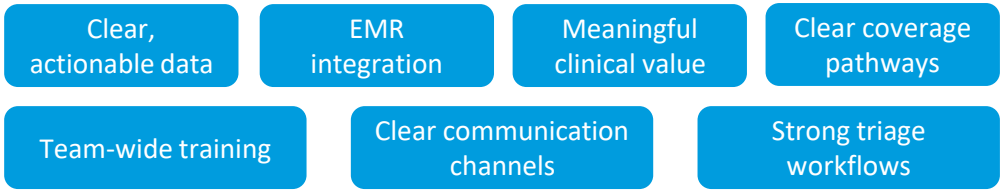
> ***"Dexterity issues, if they're too young to be able to use it. If the parent doesn't know how to use it. If they're older and just have trouble following instructions****, then they can have trouble. If they're on a* ***camping trip and their receptacle to gather urine is not available****"*
>
> **HCP15, Family Medicine, Midwest**

> *"Most of my patients, I try them to get a CGM, but not for ketones. Then when I discuss with them [I say],* ***'Okay, you are variable here. See, this is where you can be at risk for DKA'"***
>
> **HCP6, Endocrinology, South**

CGM, continuous glucose monitoring; DKA, diabetic ketoacidosis; HCP, healthcare provider

Continuous ketone monitoring technology could overcome multiple barriers, but would require substantial education

- With existing technology, provider workload and workflow pressures hinder timely ketone monitoring
- Providers felt that continuous ketone monitoring technology is potentially helpful
  - Potential to integrate into clinical workflows and electronic systems
  - Particularly helpful for older adults and those with limited access to care or support
  - More comfortable and convenient than to urine test strips
- Successful adoption requires:



*"[CGM] has been a game changer because **they didn't have to do the finger pokes anymore**, and we were able to see when they—**in the middle of the night if they're going low**. If a continuous ketone monitor, again, was a **more comfortable way of monitoring your ketones**, then that would be an advantage."*

HCP2, Endocrinology, Midwest

*"I think that if I were to adopt something like that, I would **want to really see the data surrounding it in terms of its ability to prevent DKA and financial cost, and also data about psychological impact and quality of life**."*

HCP2, Endocrinology, Midwest

*"I don't have experience on a day-to-day management of ketone levels, **so it would involve a little bit more training for everyone, myself included**."*

HCP5, Pediatric Endocrinology, Midwest

CGM, continuous glucose monitoring; CKM, continuous ketone monitoring; EMR, electronic medical record; HCP, healthcare provider

Discussion

- Guidance on ketone monitoring is often lacking, and providers reporting many people with diabetes to be disinclined to test their levels
- Providers reported that the effectiveness of ketone management is limited by currently available monitoring technology
- Providers felt that continuous ketone monitoring technology:
  - Has the potential to allow people with diabetes to effectively monitor their own ketone levels
  - Would be a convenient alternative to urine test strips

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