Blood versus urine ketone monitoring in a pediatric cohort of patients with type 1 diabetes: a crossover study

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Background

Diabetes ketoacidosis (DKA) is the most severe complication in type 1 diabetes (T1D) but patient education and ketone monitoring may help decrease its frequency. However, the influence on glucose homeostasis of systematic ketone monitoring and of the nature of monitoring (urine vs blood) is unclear.

Objective and hypotheses

To determine whether the use of blood ketone monitoring, as compared to urine ketone testing, decreases the duration of hyperglycemia, the occurrence of ketosis events and of DKA in the daily management of T1D in pediatrics.

Method

Our single-site, controlled and randomized study was performed on prepubertal patients with T1D outside of remission phase. Over 118 patients screened, 28 were actively enrolled. Patients were asked to test ketone production during hyperglycemic episodes (HE), being 2 consecutive (but 1 hour delayed) capillary glycemia ≥ 250 mg/dL, during 2 periods of 6 months alternatively with a blood ketone meter (GlucoMen® LX Plus, Menarini diagnostics) and urine ketone test strips (Keto-Diastix®, Bayer).

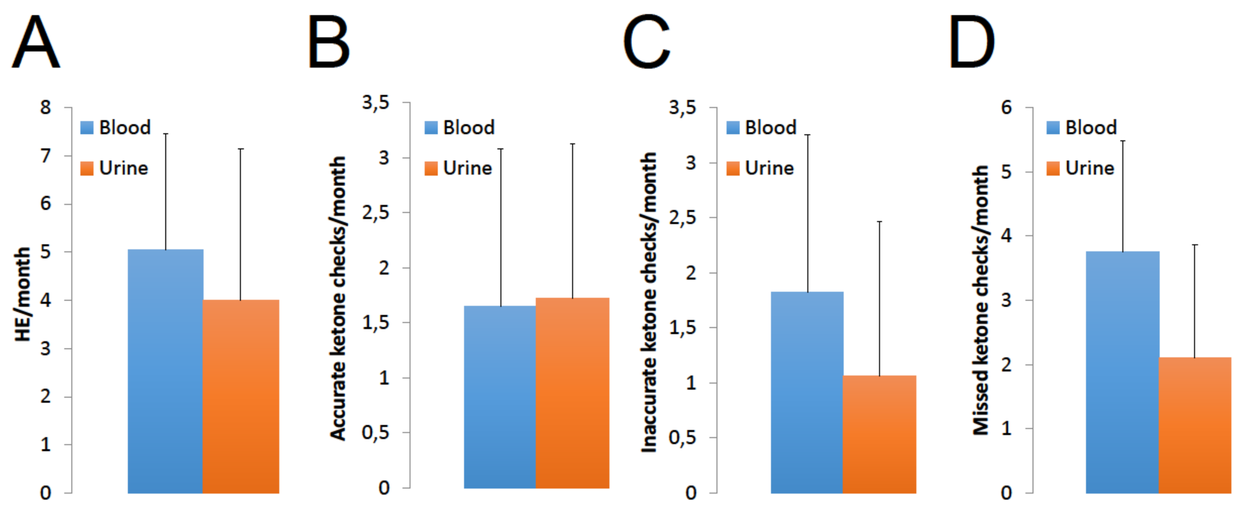

Figure 1 legend: Graphs show no significant differences between blood and urine ketone groups in monthly occurrence of hyperglycemic episodes (A), accurate ketone checks (B), and inaccurate ketone checks (C). Contrarily, missed ketone checks tended to be more frequent when patients controlled ketones with blood meter (D, *P*=0.05).

Results

Our cohort was homogeneous for gender (F/M ratio: 1), age (mean 10.4 years) and diabetes duration (≥2 years). During the study period, no episodes of DKA or severe hypoglycemia were noticed. Patients experienced a mean of 4.6 hyperglycemic episodes (HE) per month (range 0-9) (**Fig. 1A**). They adequately controlled ketones 1.6 times/month (36% of HE) (**Fig. 1B**) and inadequately (when no HE occurred) 1.5 times/month (**Fig. 1C**). Missed ketone bodies measurements (2.9/month) tended to be higher with blood meter (3.7/month) than with urine strips (2.1/month) (*P*=0.05) (**Fig. 1D**). Duration of hyperglycemia during HEs was not different when patients measured or not ketones (4.3 ± 1.9 *vs* 4.3 ± 2.0 hours, respectively), meaning that ketone monitoring did not allow rapid normalization of glycemia. The proportion of severe ketosis (>3 mM for blood and >28 mM for urine tests) was similar between the two groups (4% for urine and 5% for blood monitoring). Also, no difference was noticed in mean blood glucose or $HbA1_C$ levels before and after the study period.

Conclusions

Whereas ketone monitoring is part of standardized diabetes education, its implementation in the daily routine remains difficult. Although we did not observe DKA, ketone monitoring did not impact glycemic control during our study. Further research is necessary to evaluate how ketone monitoring may impact long-term diabetes control and complications.

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