

Nocturnal Continuous Glucose and Sleep Stage Data in Adults with Type 1 Diabetes in Real-World Conditions

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Abstract

Background:

Sleep plays an important role in health, and poor sleep is associated with negative impacts on diabetes management, but few studies have objectively evaluated sleep in adults with type 1 diabetes mellitus (T1DM). Nocturnal glycemia and sleep characteristics in T1DM were evaluated using body-worn sensors in real-world conditions.

Methods:

Analyses were performed on data collected by the Diabetes Management Integrated Technology Research Initiative pilot study of 17 T1DM subjects: 10 male, 7 female; age 19–61 years; T1DM duration 14.9 ± 11.0 years; hemoglobin A1c (HbA1c) $7.3\% \pm 1.3\%$ (mean \pm standard deviation). Each subject was equipped with a continuous glucose monitor and a wireless sleep monitor (WSM) for four nights. Sleep stages [rapid eye movement (REM), light, and deep sleep] were continuously recorded by the WSM. Nocturnal glycemia (mg/dl) was evaluated as hypoglycemia (<50 mg/dl), low (50–69 mg/dl), euglycemia (70–120 mg/dl), high (121–250 mg/dl), and hyperglycemia (>250 mg/dl) and by several indices of glycemic variability. Glycemia was analyzed within each sleep stage.

Results:

Subjects slept 358 ± 48 min per night, with 85 ± 27 min in REM sleep, 207 ± 42 min in light sleep, and 66 ± 30 min in deep sleep (mean \pm standard deviation). Increased time in deep sleep was associated with lower HbA1c ($R^2 = 0.42$; $F = 9.37$; $p < .01$). Nocturnal glycemia varied widely between and within subjects. Glycemia during REM sleep was hypoglycemia $5.5\% \pm 18.1\%$, low $6.6\% \pm 18.5\%$, euglycemia $44.6\% \pm 39.5\%$, high $37.9\% \pm 39.7\%$, and hyperglycemia $5.5\% \pm 21.2\%$; glycemia during light sleep was hypoglycemia $4.8\% \pm 12.4\%$, low $7.3\% \pm 12.9\%$, euglycemia $42.1\% \pm 33.7\%$, high $39.2\% \pm 34.6\%$, and hyperglycemia $6.5\% \pm 20.5\%$; and glycemia during deep sleep was hypoglycemia $0.5\% \pm 2.2\%$, low $5.8\% \pm 14.3\%$, euglycemia $48.0\% \pm 37.5\%$, high $39.5\% \pm 37.6\%$, and hyperglycemia $6.2\% \pm 19.5\%$. Significantly less time was spent in the hypoglycemic range during deep sleep compared with light sleep ($p = .02$).

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Abbreviations: (CGM) continuous glucose monitor, (DMITRI) Diabetes Management Integrated Technology Research Initiative, (EEG) electroencephalogram, (ESS) Epworth sleepiness scale, (GV) glycemic variability, (HbA1c) hemoglobin A1c, (SWS) slow wave sleep, (T1DM) type 1 diabetes mellitus, (TST) total sleep time, (WSM) wireless sleep monitor

Keywords: hypoglycemia, real-world monitoring, sleep, type 1 diabetes mellitus

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Abstract cont.**Conclusions:**

Increased time in deep sleep was associated with lower HbA1c, and less hypoglycemia occurred in deep sleep in T1DM, though this must be further evaluated in larger subsequent studies. Furthermore, the consumer-grade WSM device was useful for objectively studying sleep in a real-world setting.

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