

# Continuous Glucose Monitoring with Multiple Daily Insulin Injections Improves Perinatal Outcomes in Females with Type 1 Diabetes Mellitus

**Authors:** \*Kateřina Anderlova,<sup>1,2</sup> Hana Krejčí, MD,<sup>1,2</sup> Miloš Mráz,<sup>3</sup> Martin Haluzík,<sup>3</sup> Michal Kršek,<sup>1</sup> Antonín Pařízek,<sup>2</sup> Patrik Šimják<sup>2</sup>

1. 3<sup>rd</sup> Department of Medicine, First Faculty of Medicine, Charles University and General University Hospital, Prague, Czech Republic
2. Department of Gynecology and Obstetrics, First Faculty of Medicine, Charles University and General University Hospital, Prague, Czech Republic
3. Diabetes Centre, Institute for Clinical and Experimental Medicine, Prague, Czech Republic

\*Correspondence to katerina.anderlova@vfn.cz

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**Keywords:** Caesarean section, continuous glucose monitoring (CGM), continuous subcutaneous insulin infusion (CSII), hypoxia, large for gestational age (LGA), multiple daily insulin (MDI) injections, operative delivery, perinatal outcomes, self-monitoring of blood glucose (SMBG), Type 1 diabetes mellitus (T1DM).

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## BACKGROUND AND AIMS

Females with Type 1 diabetes mellitus (T1DM) are at increased risk of adverse pregnancy outcomes.<sup>1</sup> Compared to the general population, there is a higher prevalence of congenital malformations, caesarean delivery, fetal macrosomia, large for gestational age (LGA) infants, pre-eclampsia, preterm delivery, and neonatal mortality.<sup>2-4</sup> Insulin regimens in pregnancy include multiple daily insulin (MDI) injections and continuous subcutaneous insulin infusion (CSII) via insulin pumps.<sup>5-7</sup> With advancing technologies,

continuous glucose monitoring (CGM) is increasingly used in antenatal care at the expense of self-monitoring of blood glucose (SMBG).<sup>8-10</sup> The aim of the authors' study was to evaluate the effectiveness of different management options on perinatal and neonatal health outcomes.

## MATERIALS AND METHODS

The authors performed a retrospective cohort study of 232 pregnant females with T1DM from a single university-affiliated perinatal centre in the Czech Republic. Females were divided into four groups, according to the mode of glucose monitoring and treatment: SMBG with MDI injections (SMBG+MDI), SMBG with CSII (SMBG+CSII), CGM with MDI injections (CGM+MDI), CGM with CSII (CGM+CSII). Data were retrieved from the electronic medical records.

## RESULTS

Overall, 35.3% of females attended preconception counselling, with more females in CGM+CSII and less in the SMBG+MDI group (52.7% versus 18.2%;  $p=0.002$ ). The authors observed lower mean HbA1c concentrations prior to conception in CGM+MDI and CGM+CSII groups ( $55.1\pm 15.3$  and  $54.3\pm 12.4$ , respectively;  $p=0.005$ ). On univariate analysis, a higher rate of liveborn infants (97.0%;  $p=0.031$ ) was observed in the CGM+MDI group. There was a higher incidence of operative delivery (caesarean section or instrumental vaginal delivery) in the SMBG+CSII (81.3%;  $p=0.048$ ) group and fewer cases of LGA infants among females with CGM+MDI, but more in the CGM+CSII group (18.8% versus 48.1%;  $p=0.039$ ). There were no cases of umbilical artery pH  $<7.15$  in the CGM+MDI group (0;  $p=0.006$ ). Perinatal results are summarised in [Table 1](#). Logistic regression showed that CGM+MDI decreases the odds of operative delivery (odds ratio [OR]: 0.29; 95% confidence interval [CI]: 0.116–0.707;  $p=0.007$ ), LGA (OR: 0.34; 95% CI: 0.124–0.923;  $p=0.034$ ), and umbilical artery pH  $<7.15$  (OR: 0.04; 95% CI: 0.002–0.790;  $p=0.034$ ). The results did not reach statistical significance after adjusting for maternal age, BMI, diabetes compensation, and morbidity.

**Table 1: Perinatal results for operative delivery, caesarean section, or instrumental vaginal delivery.**

Outcome	SMBG+MDI	SMBG+CSII	CGM+MDI	CGM+CSII	Total	p
	n=47	n=75	n=32	n=54	n=208	
Liveborn infants (% of total)	47 (85.5%)	74 (83.1%)	32 (97.0%)	53 (96.4%)	206 (88.8%)	0.031
Pre-eclampsia/HELLP	5 (10.6%)	4 (5.3%)	3 (9.4%)	3 (5.6%)	14 (6.7%)	0.645
Intrahepatic cholestasis of pregnancy	1 (2.1%)	1 (1.3%)	2 (6.3%)	2 (3.7%)	6 (2.9%)	0.539
Gestational age at delivery (weeks, days)	38w1d±1w4d	38w0d±1w3d	38w0d±2w3d	38w1d±1w0d	38w1d±1w5d	0.949
Preterm birth <34 weeks	1 (2.1%)	3 (4.0%)	2 (6.3%)	1 (1.9%)	7 (3.4%)	0.679
<b>Onset of delivery</b>						
Spontaneous onset	20 (42.6%)	21 (28.0%)	13 (40.6%)	20 (37.0%)	74 (35.6%)	0.359
Labour induction	8 (17.0%)	15 (20.0%)	9 (28.1%)	8 (14.8%)	40 (19.2%)	
Elective C-section	19 (40.4%)	39 (52.0%)	10 (31.3%)	19 (35.2%)	87 (41.8%)	
<b>Operative delivery</b>	29 (61.7%)	61 (81.3%)	19 (59.4%)	38 (70.4%)	147 (70.7%)	0.048
Birthweight (g)	3,338±101	3,356±81	3,355±123	3,675±95	3,528±697	0.135
LGA infant	17 (36.2%)	29 (38.7%)	6 (18.8%)	26 (48.1%)	79 (38.0%)	0.039
SGA infant	1 (2.1%)	3 (4.0%)	2 (6.3%)	3 (5.6%)	9 (4.3%)	0.789
Respiratory distress	9 (19.1%)	10 (13.3%)	8 (25.0%)	14 (25.9%)	41 (19.7%)	0.241
<b>Umbilical artery pH &lt;7.15</b>	10 (21.3%)	7 (9.3%)	0	11 (20.4%)	28 (13.5%)	0.006
Umbilical artery pH	7.22±0.02	7.26±0.01	7.27±0.02	7.22±0.01	7.25±0.09	0.056
Neonatal hypoglycaemia	22 (46.8%)	42 (56.0%)	18 (56.3%)	30 (55.6%)	112 (53.8%)	0.622
Phototherapy for neonatal jaundice	13 (27.7%)	17 (22.7%)	8 (25.9%)	14 (25.9%)	52 (25.0%)	0.945
Congenital malformations	4 (8.5%)	4 (5.3%)	2 (6.3%)	3 (5.6%)	13 (6.3%)	0.916
Diabetic fetopathy	2 (4.3%)	9 (12.0%)	1 (3.1%)	6 (11.1%)	18 (8.7%)	0.264
NICU admission	9 (19.1%)	12 (16.0%)	6 (18.8%)	8 (14.8%)	35 (16.8%)	0.942
Hospitalisation length after delivery (days)	5.5±2.3	6.9±4.3	8.1±12.5	7.2±9.2	6.9±7.3	0.469

CGM: continuous glucose monitoring; C-section: caesarean section; CSII: continuous subcutaneous insulin infusion; d: days; HELLP: haemolysis, elevated liver enzymes, and low platelet count syndrome; LGA: large for gestational age; MDI: multiple daily insulin; NICU: neonatal intensive care unit; SGA: small for gestational age; SMBG: self-monitoring of blood glucose; w: weeks.

## CONCLUSION

The authors' study suggests that perinatal outcomes of females with T1DM are affected by the modality of glucose monitoring and insulin regimen. CGM together with MDI injections are associated with lower rates of operative delivery, LGA infants, and fetal hypoxia. ■

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