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SHORT SCIENTIFIC REPORT

Incidence of hypoglycaemia in fasting children after induction of anaesthesia for elective procedures: a descriptive observational study

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Editor,

Hypoglycaemia should always be of specific concern for anaesthesiologists as clinical signs of hypoglycaemia are concealed during anaesthesia. A new definition of intraoperative hypoglycaemia in children was recently defined at blood glucose values less than $3.3\,\text{mmol}\,\text{l}^{-1}$ ($60\,\text{mg}\,\text{dl}^{-1}$) by Riegger *et al.* in a large, multicentre, retrospective study.[1] This study found an incidence of hypoglycaemia in 3.9% of children, but blood glucose had only been measured in 6.6% of children included in the study, thus not indicating the true incidence of hypoglycaemia. Studies estimating the incidence of hypoglycaemia in children during anaesthesia were mostly published prior to the 1980s.[2–4] All these studies included a small number of patients in selective groups, with varied definitions for hypoglycaemia, which resulted in a wide range of perioperative hypoglycaemia. As many of these studies indicated that younger children were at higher risk for hypoglycaemia, the focus has mostly been on monitoring blood glucose in the youngest age group.

In this retrospective single-centre study, data on blood glucose measurements were prospectively collected as a part of a quality improvement initiative aimed at assessing the glucose control of children with prolonged fasting. The aim was to investigate the incidence of hypoglycaemia in children undergoing anaesthesia in modern settings and ascertain if there was a relationship between hypoglycaemia and both the child's age and prolonged fasting.

Parents were instructed at the preop assessment to ensure that the child had no solid food by mouth from midnight, but that clear fluids were allowed and encouraged until 2 h prior to the estimated start of the surgery. Blood glucose was measured after induction of anaesthesia in children undergoing elective procedures at Landspitalinn, the National University Hospital of Iceland (Reykjavik, Iceland) between January and June 2021. The inclusion criterion was children aged 18 years and younger. Children with ongoing treatment that could influence fasting blood glucose were not included (ongoing intravenous fluids, betablocker treatment, corticosteroid treatment, and/or insulin treatment). Glucose measurements were performed by a separate capillary puncture, but when comparing measurements with those obtained from the central laboratory, blood samples were acquired by venepuncture. Capillary blood glucose measurements were performed with a bedside blood glucose monitoring device (On Call Vivid glucose meter, Acon Laboratories Inc., San Diego, California, USA) within 5 min after induction of anaesthesia. The precision of capillary bedside glucose measurements is 10 to 20% at lower values of blood glucose ($\pm$ 0.3 to $0.6\,\text{mmol}\,\text{l}^{-1}$), meaning that a value might be as low as $2.7\,\text{mmol}\,\text{l}^{-1}$ in blood glucose despite a measurement of $3.3\,\text{mmol}\,\text{l}^{-1}$. Venous samples were only available if they were requested as a part of the anaesthesia care during the procedure. If blood glucose measured less than $3.3\,\text{mmol}\,\text{l}^{-1}$, an infusion containing glucose was started and blood glucose was measured again at the end of the procedure. All parents were informed of the ongoing quality initiative. Approval for this study (nr. 30/2022) was granted for a retrospective analysis of data by the Ethical Committee of Landspitalinn, University Hospital of Iceland, Reykjavik, Iceland (Chair Dr O. Samuelsson), 3 November 2022.

Statistical analysis was performed using Statistica 13 (Dell, USA) where comparison between normoglycaemic and hypoglycaemic patients was done by Student's t test and was considered statistically significant if the difference between the groups had a P value less than 0.05. A linear model of fasting glucose as a function of fasting

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Table 1 **Procedures in the study requiring anaesthesia**

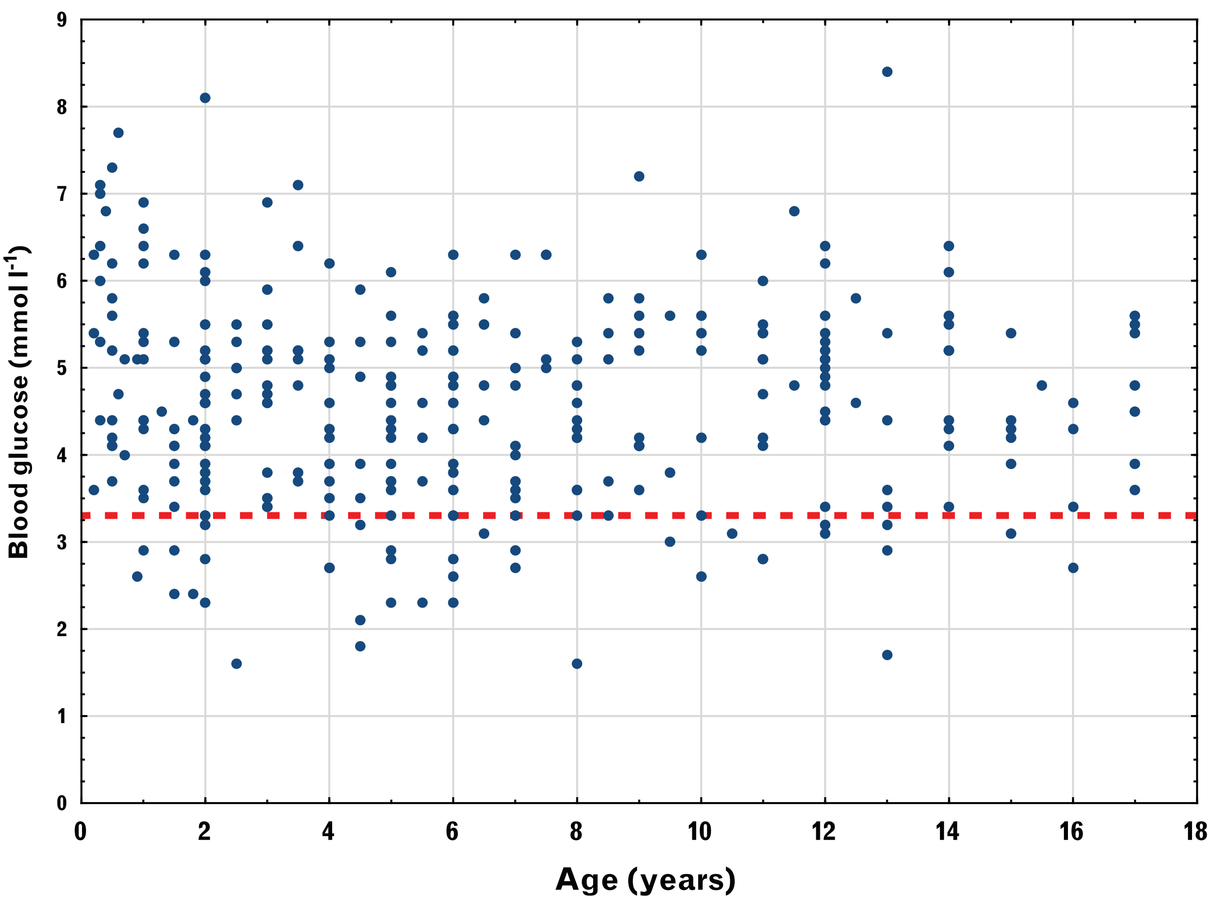
Type of procedure	Total number
Paediatric surgery	116 (39%)
Magnetic resonance imaging	51 (17%)
Endoscopies	48 (16%)
Medicine	37 (12%)
Dental surgery	31 (10%)
Optical surgery	17 (6%)

duration and age was fitted, and logistic regression performed to describe the odds of perioperative hypoglycaemia as a function of fasting duration and age. The normality of model residuals was visually assessed with a Q-Q-plot.

Incidence of hypoglycaemia was 12.3% [95% confidence interval (CI), 8.8 to 16.6%] in 37 out of the 300 children (male 63%) that were included in the study (Table 1 and Fig. 1). The mean age was 6.4 years (range 0.2 to 17 years, SD 4.6 years) and mean weight 26.2 kg (range 3.7 to 103 kg, SD 17.5 kg). The lowest measured blood glucose level measured was 1.6 mmol l^{-1}. Mean fasting time was 13 h (range 4 to 24 h, SD 3.9 h) for solids and 8.5 h (range 1 to 18 h, SD 4.8 h) for fluids. In the linear model, each year of change corresponded to a change in glucose of −0.01 (95% CI, −0.04 to 0.02) mmol l^{-1} ($P = 0.504$), and each hour of fluid fasting corresponded to a change in glucose of −0.03 (95% CI, −0.06 to 0.00) mmol l^{-1} per hour ($P = 0.054$). However, there was a significant association between the change in glucose and solid food fasting of −0.07 (95% CI, −0.10 to −0.03) mmol l^{-1} change per hour of solid food fasting ($P < 0.001$) that remained largely unchanged after adjustment for age, −0.07 (95% CI, −0.10 to −0.03) mmol l^{-1} change per hour of solid food fasting ($P < 0.001$). Similarly, the multivariable logistic model revealed that there were increased odds of hypoglycaemia with increased duration of solid food fasting (OR 1.10 (95% CI, 1.00 to 1.20) per hour of fasting, $P = 0.04$) that remained significant after adjustment for age (OR 1.10 (95% CI, 1.01 to 1.21) per hour of fasting, $P = 0.04$).

The main purpose of strict preoperative fasting guidelines is to reduce the risk of aspiration of gastric contents during anaesthesia. At the same time, it is important to

Fig. 1 Fasting blood glucose measurements in 300 children related to age (dashed line indicates hypoglycaemia below 3.3 mmol l^{-1}).



Mean fasting blood glucose value was 4.6 mmol l^{-1} (range 1.6 to 8.4 mmol l^{-1}, SD 1.2 mmol l^{-1}). SD, standard deviation.

minimise fasting times as much as possible to reduce patient discomfort and risks related to hypovolaemia and hypoglycaemia. It has been hypothesised that blood glucose rises during anaesthesia because of stress, lower metabolic demand and reduced insulin response, and thus children apart from newborns do not need maintenance fluids with glucose during shorter procedures. However, this assumes that blood glucose is within the normal range at the beginning of anaesthesia and does not consider that anaesthesia is often provided for minor investigations. It is unclear whether treating asymptomatic hypoglycaemia is beneficial if it is likely to be transient in nature because of the patient resuming oral intake shortly after surgery. However, the very limited risk of treating or preventing it must be weighed against the risk of an adverse neurological outcome of prolonged or extreme hypoglycaemia, in particular where clinical assessment is impaired because of the effects of anaesthesia. International guidelines have, until recently, recommended 6 h fasting for solid food and 2 h for clear fluids prior to anaesthesia.[5] The Safe Anesthesia for Every Child (SAFETOTS) initiative by the European Society for Paediatric Anaesthesiology (ESPA) recommends 10 key factors that should be sustained perioperatively, with normoglycaemia being one of those factors.[6] As undetected hypoglycaemia during anaesthesia can have devastating consequences, it was alarming that blood glucose was only measured in half of the smallest and most vulnerable patients according to the NECTARINE study.[7]

Our results confirm that fasting times for children at our hospital are too long, despite vigorous education and strong emphasis in recent years to limit fasting before anaesthesia. A limitation of this study, and possibly why we were not able to detect lower fasting blood glucose in younger children, might be that they were scheduled earlier in the day on operation lists.

In summary, the incidence of hypoglycaemia in children after anaesthesia induction was higher than expected in this study and fasting blood glucose levels were stable between all age groups, with older children at the same risk of hypoglycaemia as younger children. It is our opinion, that blood glucose should be measured more routinely in children undergoing anaesthesia.

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