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Commentary

Inpatient hypoglycaemia; should we should we focus on the guidelines, the targets or our tools?

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In their thought-provoking commentary, Levy *et al.* [1] explore the possible unintended consequences of United Kingdom (UK) guideline targets on the high frequency of

hypoglycaemia in people with diabetes who are hospitalized. The authors cite the National Institute for Health and Care Excellence (NICE) and the Joint British Diabetes Societies (JBDS) guidelines pertaining to inpatient, surgical and pregnancy diabetes care. These guidelines suggest using lower limits of glucose targets varying from 4.0 to 6.0 mmol/l [2–4]. Levy *et al.* propose a lower glucose limit of 5 mmol/l with the catchphrase 'stop at 5 and keep the inpatient alive'. Because one in every five inpatients with diabetes experiences a hypoglycaemic episode, there is no doubt that measures must be taken to minimize this potentially serious complication [5]. We agree that, for many if not all, inpatients with diabetes, a 'floor of 4' may be too low and thus contribute to potentially modifiable hypoglycaemia. We suggest that the current tools and how they are implemented (often suboptimally) by non-specialist staff on busy wards also contribute to the persistently high rates of inpatient hypoglycaemia and insulin errors.

Regardless of the lower threshold glycaemic targets, our current inpatient diabetes tools cannot achieve and maintain precise glucose concentrations of 4.0 vs. 5.0 mmol/l. Current methods of inpatient diabetes treatment include variable rate intravenous insulin infusion (VRIII), subcutaneous insulin, oral medications and, to a lesser extent, continuous subcutaneous insulin infusion (CSII). VRIII is typically used in acute settings such as critical care, labour and delivery, surgery with prolonged fasting, diabetic ketoacidosis and acute decompensated diabetes. Based on hourly capillary glucose testing, the rate of intravenous insulin is adjusted by ward staff. This is invasive, resource intensive and by its nature, reactive. The VRIII allows for very little personalization and is managed by busy ward staff who may have limited diabetes training and many competing interests. The concern with VRIII as a tool in diabetes inpatient

management is echoed by the guidelines and the National Diabetes Inpatient Audit (NaDIA), which recommend use of VRIII only when clearly indicated [3,5].

Unfortunately, VRIII is the current gold standard for high-acuity clinical scenarios that require careful and quick insulin titration, but as a gold standard it is disappointing.

At the upper glycaemic threshold, JBDS guidelines for the management of adults with diabetes undergoing surgery and elective procedures propose an acceptable blood glucose of up to 12 mmol/l (target: 6–10 mmol/l) in the surgical population. For inpatients who are stable and in whom tight control is safely achieved, aiming for higher glycaemic targets may seem counter-intuitive. In reality, the risk of impaired wound healing with higher glycaemic targets needs to be weighed against the possible increased risk of hypoglycaemia with tighter targets [6].

In the intrapartum management of diabetes, glycaemic targets are based in part on the rationale that maternal hyperglycaemia during this time may increase the risk of neonatal hypoglycaemia. It is beyond doubt that maternal hyperglycaemia during the second and third trimesters is clearly associated with fetal hyperinsulinaemia, neonatal hypoglycaemia and neonatal intensive care unit admission [7,8]. However, we completely agree that there are insufficient data supporting a clear association between short duration intrapartum hyperglycaemia and newborn hypoglycaemia [9]. Direct measurements of fetal intrapartum glucose are limited, but historical data suggest that the placenta prevents unlimited transport of glucose to the fetus during labour, regardless of the degree of maternal hyperglycaemia [10].

Pregnant women with Type 1 diabetes increasingly prefer to self-manage their glucose control during hospital admissions and may achieve effective inpatient glucose control using insulin pump or novel automated glucose-responsive closed-loop insulin delivery [11,12]. We recently reported preliminary data of closed-loop insulin delivery during labour and delivery

with an intrapartum glucose target of 3.5–7.8 mmol/l [12]. Women spend > 80% of time in target during the 24 h prior to delivery. Importantly, this tight glycaemic control was achieved with little time spent in hypoglycaemia. A 'floor of either 4 or 5' while using automated insulin delivery, especially in closely (and increasing continuously glucose monitored) labour and delivery units may be reasonable. However, without automated insulin delivery and with the current tight glycaemic targets during this period, maternal hypoglycaemia is far too common [9].

Outside labour and delivery, closed-loop insulin delivery has been shown to improve time-in-target without increasing hypoglycaemia in inpatients with diabetes in critical care and hospital ward settings [13,14]. These studies also highlight suboptimal glucose control in standard inpatient care: 41% time spent in the target range of 5.6–10.0 mmol/l in hospital ward settings and 73% in the critical care setting using VRIII. The comparable time-in-target values using closed-loop insulin delivery were 66% and 92%, with negligible hypoglycaemia [13,14].

Our current tools often fall short of providing people with diabetes excellent care, especially inpatient care when glucose levels and insulin requirements fluctuate. It is our hope that automated insulin delivery will replace the need for VRIII and subcutaneous insulin dosing in a way that protects from inpatients from hypoglycaemia. Until then, inpatient diabetes management must continue to be an intricate balancing act; one that considers hypo- and hyperglycaemia, safety and resource use, guidelines and person-centred care, and the acuity and invasiveness of treatment. It is our hope that better tools will ultimately improve day-to-day glucose control in people with diabetes during admission to hospital. Until then, stopping at five to keep the in-patient alive may be the safest option.

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Competing interests

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