OBSERVATIONS

Accuracy and Reliability of Continuous Glucose Monitoring in the Intensive Care Unit: A Head-to-Head Comparison of Two Subcutaneous Glucose Sensors in Cardiac Surgery Patients

Hyperglycemia, hypoglycemia, and glucose variability are common during intensive care unit (ICU) stay and are associated with increased mortality (1–3). Continuous glucose monitoring (CGM) is a promising tool to assist glucose control, but the accuracy and reliability of these devices in critically ill patients is uncertain (4,5). Therefore, we studied two different CGM devices postoperatively in cardiac surgery patients in an investigator-initiated trial.

We placed two CGM devices (Guardian RT, Medtronic Minimed; FreeStyle Navigator, Abbott Diabetes Care) subcutaneously in the abdominal wall before surgery in 60 patients. This is the first time the Navigator has been studied in an ICU setting. Both devices were calibrated simultaneously upon arrival at the ICU after surgery. Further calibrations were performed according to manufacturers' instructions. An arterial blood glucose value was measured with an AccuChek device (Performa II, Roche/Hitachi) as a reference value every 2 hours. Relative absolute deviation (RAD) between reference and sensor glucose values was calculated in six 5-min intervals after the time of the reference glucose to assess a possible delay.

Of the 60 patients, 48 were male with a median (range) age of 65 years (25–85), and 16 were diagnosed with type 2 diabetes. The median (IQR) maximum Sequential Organ Failure Assessment score and ICU stay were 6.0 (5.3–7.0) and 23.0 hours (19.0–45.8), and mean (SD) glucose was 8.2 (2.1) mmol/L. We obtained 1,017 reference glucose values of which 77.8% could be paired with a Guardian and 91.8% with a Navigator value in the first interval. Missing values indicate technical problems with the device: signal loss (Guardian: 19 patients; Navigator: 1 patient), sensor failure (Guardian: 7 patients; Navigator: 2 patients), interruption of real-time representation of glucose values after delayed recalibration (Guardian) or temporarily failure of data-recording (Navigator: 4 patients).

Median (IQR) RAD was significantly smaller for Navigator compared with Guardian glucose measurements at intervals 0–4 and 5–9 min after the reference glucose (11% [8–16] and 10% [8–16] compared with 14% [11–18] and 14% [11–17], $P = 0.05$ and $P = 0.001$, Wilcoxon signed rank test). The lowest RAD of the Navigator was observed 5–9 min after reference glucose, but no significant effect of time was seen ($P = 0.74$, repeated measures ANOVA). The accuracy of the Guardian did show a delay with the lowest RAD after 15–19 min (11% [8–13], $P = 0.01$). There was no consistency in under- or overestimation of the reference glucose values. No separate analyses to assess accuracy during hypoglycemia were performed because no severe hypoglycemia (≤2.2 mmol/L) was measured and only 34 of 1,017 reference glucose values were mildly hypoglycemic (≤4.7 mmol/L) (1).

We report that the FreeStyle Navigator CGM system performed better than the Guardian RT in accuracy as well as reliability in postoperative cardiac surgery patients during ICU stay. Remarkably, the RAD of both sensors was quite good compared with reported data for outpatients. According to these results, we conclude that this device can be used in this group of ICU patients characterized by relatively low disease severity scores and low mortality rates. Whether or not the use of CGM improves glycemic control and mortality needs further research.

SARAH E. SIEGELAAR, MD[1]
TEMO BARWARI, MSC[1]
JEROEN HERMANIDES, MD, PHD[1]
WIM STOOKER, MD[2]
PETER H.J. VAN DER VOORT, MD, PHD[3]
J. HANS DEVRIES, MD, PHD[1]

From the [1]Department of Internal Medicine, Academic Medical Centre, Amsterdam, the Netherlands; the [2]Department of Cardiothoracic Surgery, Onze Lieve Vrouwe Gasthuis, Amsterdam, the Netherlands; and the [3]Department of Intensive Care Medicine, Onze Lieve Vrouwe Gasthuis, Amsterdam, the Netherlands.

Corresponding author: Sarah E. Siegelaar, s.e.siegelaar@amc.uva.nl.

DOI: 10.2337/dc10-1882

Acknowledgments—This study was supported by a European Foundation for the Study of Diabetes/LifeScan research grant. The sensors used were provided free of charge by Medtronic Minimed and at a discounted rate by Abbott Diabetes Care. J.H.D. or institutions to which he is connected received research support and fees from speaking engagements from Abbott Diabetes Care and Medtronic. No other potential conflicts of interest relevant to this article were reported.

S.E.S. researched data, contributed to discussion, and wrote the manuscript. T.B. and J.H. researched data, contributed to discussion, and revised the manuscript for important intellectual content. W.S., P.H.J.v.d.V., and J.H.D. contributed to discussion and revised the manuscript for important intellectual content.

Parts of this study were presented in abstract form at the 46th Annual Meeting of the European Association for the Study of Diabetes, Stockholm, Sweden, 20–24 September 2010.

References

1. Hermanides J, Bosman RJ, Vriesendorp TM, et al. Hypoglycaemia is associated withintensive care unit mortality. Crit Care Med 2010; 38:1430–1434
2. Krinsley JS. Association between hyperglycemia and increased hospital mortality in a heterogeneous population of critically ill patients. Mayo Clin Proc 2003;78:1471–1478
3. Hermanides J, Vriesendorp TM, Bosman RJ, Zandstra DF, Hoekstra JB, Devries JH. Glucose variability is associated with intensive care unit mortality. Crit Care Med 2010;38: 838–842
4. Logtenberg SJ, Kleefstra N, Snellen FT, et al. Pre- and postoperative accuracy and safety of a real-time continuous glucose monitoring system in cardiac surgical patients: a randomized pilot study. Diabetes Technol Ther 2009;11:31–37
5. Price GC, Stevenson K, Walsh TS. Evaluation of a continuous glucose monitor in an unselected general intensive care population. Crit Care Resusc 2008;10:209–216