ICU
MANAGEMENT & PRACTICE

Personalised care to improve glycaemic control in critically ill patients

Hyperglycaemia is prevalent in critical care, caused by a complex interaction of multiple feedback loops associated with inflammation as a result of immune responses, counter-regulatory responses, and high blood glucose itself. However, glycaemic control (GC) currently leads to increased hypoglycaemia, independently associated with a greater risk of death, according to a review paper published in the journal Critical Care.

"Indeed, recent evidence suggests GC is difficult to safely and effectively achieve for all patients," the paper notes. "However, recent observational analysis indirectly supports the concept that altered glycaemia, and not the underlying patient or metabolic condition, causes the increase in mortality, and thus GC is important and needs to be performed well."

Yet significant issues prevent safe, effective GC, clinically, scientifically, and technologically, the paper says.

Studies show that pancreatic function is deranged in critically ill patients displaying similarities to type 2 diabetes, namely insufficient insulin secretion in a context of decreased insulin sensitivity. The disposition index is therefore reduced, as in patients with diabetes, as a result of inflammatory and stress hormones.

An effective GC protocol or "artificial pancreas" should provide insulin similar to a normal subject, according to the paper. Essential requirements for an artificial pancreas in the ICU include: accurate real-time or high-frequency continuous glucose monitoring; continuous intravenous insulin infusion; and an adequate algorithm that automatically drives the intravenous insulin pump.

A closed-loop system with accurate continuous glucose monitoring and computer-assisted titration of insulin based on glucose measurements could permit tight GC without increasing hypoglycaemia and nursing staff workload, the paper says, adding that personalised, patient-specific GC – potentially including recognition of diabetic status or other factors – offers a route to GC that is safe.

Personalised or patient-specific GC transforms bedside GC data into accurate representations of the patient-specific metabolic state. Patient-specific models can be used to safely design GC algorithms in-silico, to minimise risk and avoid the mixed results arising from trial-and-error clinical protocol design.

"Given a metabolic model and the required insulin, nutrition, and blood glucose data to identify key parameters to personalise the model, a virtual patient might be created," the paper says. "A virtual patient is built from the combination of a metabolic model and clinical patient data, creating an in-silico representation of that patient on which new treatment approaches might be tested, either to create a new protocol and/or in real time at the bedside to guide care safely and effectively."

In short, a metabolic model captures behaviour, and a virtual patient simulator uses that model with clinical data to mimic patient behaviour to design new therapeutic approaches.

A GC protocol design with virtual patients can be highly effective at predicting GC safety and performance in clinical use. It can thus limit poor results, particularly from easily avoidable protocol design errors. "The main hurdle is the low number of validated models available," the paper points out.

At this time, the paper says, three model-based predictive GC methods have proved reliable over multiple patient types and centres. "Overall, successful model-based GC takes into account patient-specific factors. The patient's metabolic state evolves over the course of their illness, and thus this approach provides adjustments as needed within a given patient, as much as across patients," the paper explains.

To advance the safety, quality, consistency, and clinical uptake of GC in critical care, the paper authors recommend that all models should be self-validated and cross-validated; in addition, final validation of safety and performance must come in clinical (pilot and/or randomised) trials.

"GC could consider nutrition as an input certainly, and possibly as a controlled clinical input set against international guideline goal feeds. No GC care should be 'carbohydrate blind', even though closed-loop systems may operate without nutritional input," the authors write.

The authors also urge ICU clinicians to press for increasing automation and access to sensor and infusion pump data for independent processing of GC methods to increase safety and reduce workload.

Source: Critical Care

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