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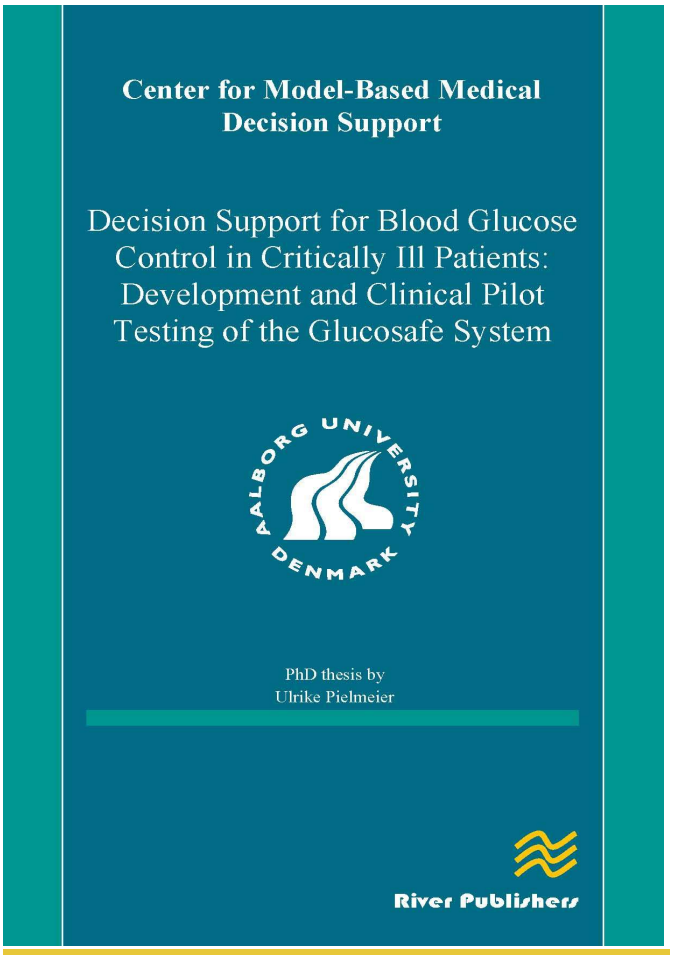
Decision Support for Blood Glucose Control in Critically Ill Patients

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Hyperglycemia in intensive care patients is associated with increased mortality and prolonged illness. Tight blood glucose control reduces mortality and morbidity in some groups of critically ill patients, but increases the risk of hypoglycemia. Fear of hypoglycemia, and the required time and effort have yet prohibited tight blood glucose control to become a standard of care in intensive care units.

This thesis hypothesizes, that a decision support system can be built that improves blood glucose control in critically ill patients without increasing the risk of hypoglycemia. The thesis summarizes the design, development and clinical pilot testing of the model-based computerized decision support system 'Glucosafe'. This system recommends not only insulin dosing, but also nutrition for optimized blood glucose control. The system is based on a physiological multi-compartment model of insulin and glucose. Insulin resistance is modeled as a time-varying, patient-specific parameter, that reduces the maximal achievable insulin effect. The model also accounts for the saturation of insulin effect at high insulin concentrations, thus preventing the recommendation of insulin doses that lead to hypoglycemia. Recommendations are based on a set of penalty functions, that minimize the risks of hypo- or hyperglycemia, undernourishment or overfeeding. Recommendations include the route of feeding, giving early enteral feeding priority over parenteral nutrition. Finally, the system includes a feature to change the advice mode, in order for the system to recommend exclusively the dosing of insulin.

A retrospective evaluation of Glucosafe's accuracy to predict blood glucose concentrations showed a median error of less than 25% by the model for predicted values up to 270 minutes ahead in time. The prospective pilot testing of Glucosafe was carried out at the neuro- and trauma intensive care unit of Aalborg hospital in Denmark. Ten hyperglycemic patients were studied in an 'off-on-off' study design. Results showed that Glucosafe improved the blood glucose control significantly. Hypoglycemia did not occur during the trial. These results are preliminary and need to be confirmed by a large randomized clinical trial to reach a definite conclusion. The thesis concludes with outlining the workflow to include Glucosafe as a standard care tool for blood glucose control in intensive care units. 11



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