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Opinion
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Hyperglycemia Management for the Non-Eating Hospitalized Patient

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Opinion

Hyperglycemia in the hospital setting is a common phenomenon and it may reflect already known diabetes, previously unrecognized diabetes or acute illness-hospital related hyperglycemia. It is well known that treatment of in-hospital hyperglycemia has beneficial effects on the short- and long-term outcomes for the patients. The not-eating hospitalized patients should be preferably treated with continuous intravenous glucose and insulin infusion, in order to benefit from the antihyperglycemic and anabolic effects of insulin. The subcutaneous insulin regimes are not preferred, because intravenous insulin can be titrated more quickly and precisely, making the risk of hyper- or hypo-glycemia less likely. It should be noticed that glucose derangements are very easy to happen in a hospitalized patient, because of the illness per se, of the alterations in the co-administered regiment, etc. In conclusion, algorithms for the treatment of hospitalized, "not-eating" patients, especially algorithms addressed to non-diabetes-specialist doctors, should focus on continuous intravenous insulin infusion based on frequent bedside glucose measurements, in order to achieve optimal glucose control.

Hyperglycemia in a hospitalized patient may reflect:

I. Already known medical history of diabetes.

II. Unrecognized diabetes: hyperglycemia (fasting blood glucose 126 mg/dl or random blood glucose 200 mg/dl) occurring during hospitalization and confirmed as diabetes after hospitalization by standard diagnostic criteria.

III. Hospital-related hyperglycemia: hyperglycemia (fasting blood glucose 126 mg/dl or random blood glucose ≥ 200 mg/dl) occurring during the hospitalization that reverts to normal after hospital discharge [1].

Hyperglycemia in the hospital setting is a common phenomenon, since:

I. Acute illness predisposes to hyperglycemia, due to increased stress hormone levels, drug reactions, inactivity, decreased glucose utilization etc.

II. Already know diabetes increases the risk for medical disorders requiring hospitalization.

Hyperglycemia per se has undesirable effects on fluid and electrolyte balance, on endothelial function, on wound healing, maybe on the immune system etc. On the other hand, aggressive treatment of diabetes and hyperglycemia results in reduced morbidity and mortality [2-4]. Nevertheless, hyperglycemia, even in the diabetic patient, is often overlooked or considered a benign condition and secondary in importance compared to the condition that prompted admission [5], attitude which is completely wrong. Nowadays it is recommended to keep glucose levels of hospitalized patients as close to normal as possible and, generally, lower than 180 - 200 mg/dl [6,7].

In the case of not-eating hospitalized patients, treatment options are very narrow. They are in fact limited to insulin administration. The route of insulin administration to a not-eating hospitalized patient has traditionally been known in the literature to be the continuous intravenous infusion. The type of insulin used in all protocols specifically developed for continuous intravenous infusion is regular crystalline insulin. There is no advantage to using rapid-acting analogs, the structural modifications of which increase the rate of absorption from subcutaneous depots, in an intravenous insulin infusion [1].

The medical literature supports the use of intravenous insulin infusion in preference to the subcutaneous route of insulin administration for several reasons shown below:

1. Not-eating patients receive continuous intravenous glucose infusion, while subcutaneous insulin creates peaks of

insulinemia of various heights and duration, depending on its type and the status of the subcutaneous tissue (dehydratation etc). So, there is no "coincidence" of glucose and insulin peaks and valleys, bringing the risk of uncontrolled hyper- or hypoglycemia ante portas.

2. Intravenously infused insulin is superior because it can be titrated more quickly and precisely. Owing to "its short half-life, possible hypoglycemia can be quickly reversed" [8], and the same holds for hyperglycemia spikes. Glucose derangements are very easy to happen in a hospitalized patient because of the illness per se, of the alterations in the co-administered regiment, etc.

3. Frequent insulin dose adjustments are mandatory in order to obtain optimal glucose control. The adjustments should be based on frequent bedside glucose testing values. The frequency of the measurements and the subsequent adjustments should be determined by the current and previous glucose levels in combination with the rate of insulin infusion as well as by the severity of the underlying illness [6]. It is obvious that such adjustments cannot be done in the case of subcutaneous insulin administration. Algorithms using subcutaneous insulin administration for the treatment of not-eating hospitalized patients with hyperglycemia are usually based on a sliding-scale regimen consisting of regular insulin without any intermediate or long-acting insulin [9]. According to these regiments, hyperglycemia is treated after it occurs and is not foreseen and prevented. In some regiments, when an undesirable glucose level is observed between the scheduled insulin doses, e.g. a value over 200mg%, an extra correction dose of regular insulin is given, usually without respect to the previously administered doses' duration curve. This leads to additive effect of the doses, with unpredictable consequences. On the other hand, any hypoglycemic value found between the scheduled insulin doses is encountered by augmenting the rate of glucose infusion, or, even worse, by administering high glucose concentration dilutes, with obvious consequences. This "reactive" approach of "supplemental" insulin or glucose administration can lead to rapid changes in blood glucose levels, exacerbating both hyper- and hypoglycemia. Moreover, regiments based on sliding-scale subcutaneous insulin administration are often prescribed on admission and remain unchanged throughout hospitalization, even when glycaemic control is not optimal. Unfortunately, these approaches are usual in everyday clinical practice in the management of hospitalized not eating patients, especially in wards where doctors are not familiar to treating diabetes.

4. The matter of "cost" in labor and money is also better addressed by continuous intravenous insulin infusion. The task of frequent bedside glucose testing is not labour-intensive, as it was originally thought to be, and can be easily performed by educated health care providers [10]. Moreover, the optimal glucose control obtained by the approach of intensive glucose determination and intravenously insulin administered dose adjustment during hospitalization, leads in cost savings because of reduced morbidity and hospital length of stay [11].

Many institutions use insulin infusion algorithms that can be implemented by nursing staff. Although numerous algorithms have been published, there have been not many head-to-head comparisons between them, leading to not uniform insulin infusion strategies between institutions. Nevertheless, some algorithms seem simple, safe and effective in controlling hyperglycemia and can be used in most hospital units, except the ICU [12]. Algorithms, in general, should incorporate the concepts that maintenance requirements differ between patients and change over the course of treatment.

When the patient becomes able to eat, the individualized appropriate antidiabetic regime (oral hypoglycemic agents, insulin therapy) should be started. For those who will require subcutaneous insulin, the very short half-life of intravenous insulin necessitates administering the first dose of subcutaneous insulin before discontinuation of the intravenous insulin infusion. If short- or rapid-acting insulin is used, it should be injected 1–2 h before stopping the infusion. If intermediate- or long-acting insulin is used alone, it should be injected 2–3 h before [1].

Finally, patients with hyperglycemia in the hospital who are not already diagnosed as having diabetes should be tested, one month after hospital discharge, for unrecognized preexisting or newly diagnosed diabetes or hospital-related hyperglycemia which reverts to normal [6]. The principals of glucose management after discharge in patients with newly diagnosed diabetes remain the same as those for patients with established diabetes [13].

In conclusion, since continuous intravenous insulin infusion is more flexible, effective, safe, simple and cost saving it must be applied in hospitalized, "not-eating" patients and it should preferably appear first on any algorithm, especially those addressed to non-specialist doctors, who treat such patients. Frequent bedside glucose measurements must be performed, in order to achieve optimal glucose control.

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