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# Inpatient Diabetes and Hyperglycemia Management Protocol in the COVID-19 Era



Dear Editor:

Diabetes and hyperglycemia are among the most common problems in hospitalized patients.

Their management may be challenging due to high volume demand, the limited number of specialty providers, and lack of knowledge or availability of standardized protocols. Insulin is one of the most crucial and effective medications used to treat hyperglycemia in health care systems but is also one of the most frequently involved in creating safety problems if not properly administered and monitored. Human error and possible miscommunication between the different layers of health care providers play a major role in the mismanagement of hyperglycemia among hospitalized patients. Standardizing common processes and procedures are strategies to improve human factors in the health care environment. Examples include avoiding reliance on memory by providing an updated, comprehensively reviewed, and simplified diagram that explains the steps of a process or procedure. Here we present a flow chart (Fig. 1) for the management of diabetes and hyperglycemia in non-critically ill patients as an attempt to standardize a protocol that may be used across different services in the hospital without the need of a diabetes specialist.

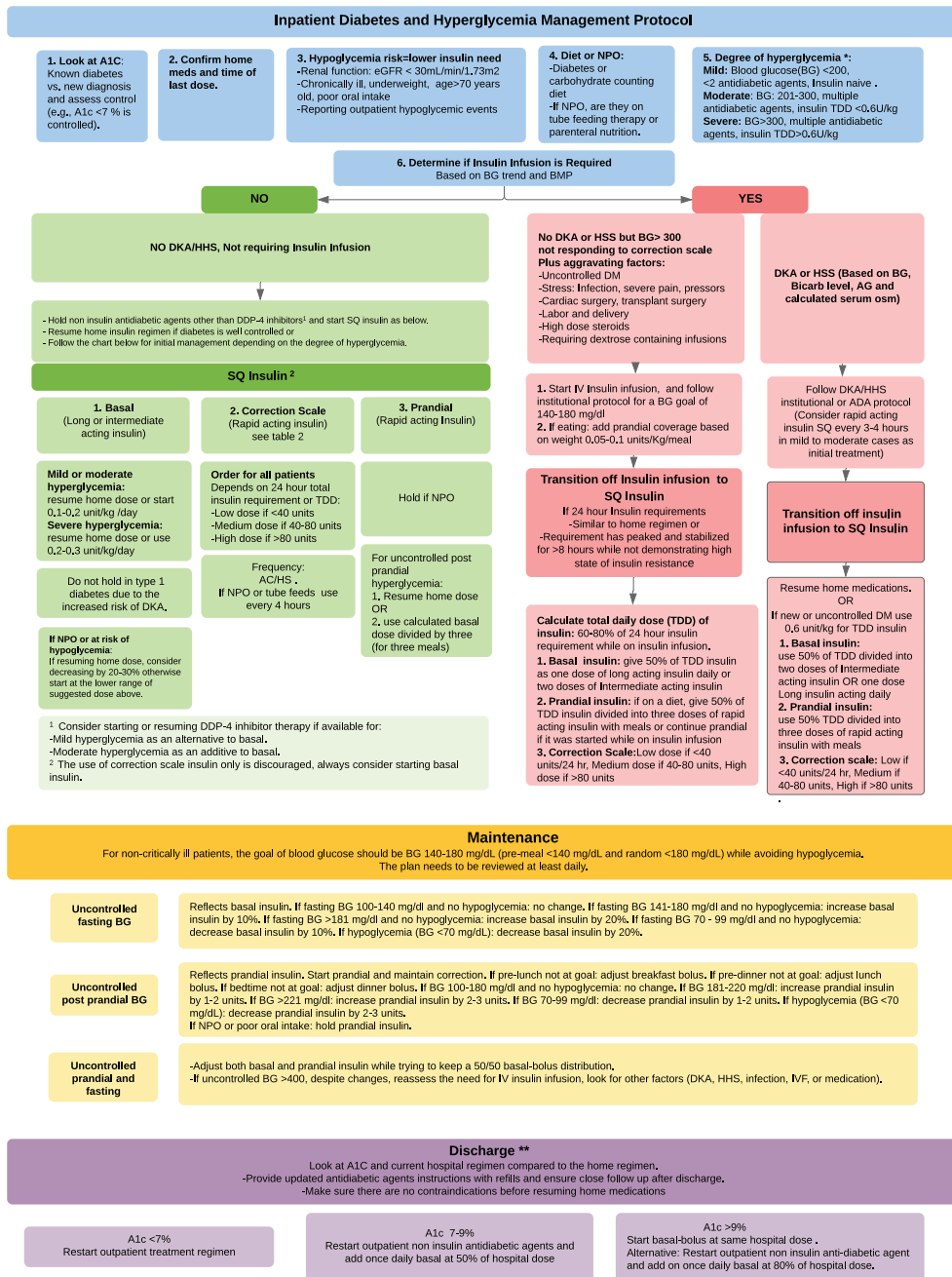
Recent studies suggest that patients with diabetes may be at a higher risk of severe COVID-19 infection.<sup>1</sup> At present, establishing a diagram that can be used anywhere in the hospital became a necessity since the COVID-19 global pandemic has added major challenges to a complex problem. Therefore, it is essential to adequately treat hospitalized patients while protecting health care workers and minimizing contact exposure due to a lack of personal protective equipment and available staff. Additionally, patients who do not have diabetes, but may be at higher risk for diabetes, should be monitored closely for the development of hyperglycemia. Due to the cytokine storm and pronounced inflammation associated with COVID-19, steroids may be used which result in increased hyperglycemia and the subsequent need to promote euglycemia using either SQ or IV insulin. Clinicians caring for patients with COVID-19 need to be aware of these possible outcomes.<sup>2-4</sup>

Strategies include lessening the frequency of blood glucose (BG) checks in patients receiving SQ insulin regimens or insulin infusions and attempting treatment of diabetic ketoacidosis/hyperosmolar hyperglycemic state (DKA/HHS) with a SQ insulin regimen. Diabetes self-management has been considered in the past to be safe

and effective in select patients,<sup>5</sup> and consideration should be given to allow a patient with intact mental status and adequate diabetes management skills to administer insulin and measure blood glucose. This would include permitting patients to continue to use and manage outpatient continuous glucose monitoring devices (CGM) and insulin pumps if they are well controlled and without contraindications such as DKA/HHS, undergoing a procedure or surgery, encephalopathy or sedation which may prevent their ability to adequately manage their CGM or insulin pump.

Insulin dosing may be challenging for providers in hospitalized patients; however, studies have shown that weight-based dosing is an effective and safe way to estimate insulin needs. Here in Table 1, we suggest a dosing approach adapted from Magaji and Johnston<sup>6</sup> and Umpierrez et al.<sup>7</sup> Total daily dose (TDD) of insulin should be given as 50% basal insulin and 50% prandial insulin. We suggest considering basal insulin with correction scale instead of correction scale only; this is based on the ADA recommendations and multiple studies that were included in a meta-analysis.<sup>5,8</sup> Prandial insulin should be considered if needed to treat postprandial hyperglycemia. For correction scale insulin, we suggest using an approach included in Table 2, but other approaches are available and may be used.<sup>7</sup> However, due to the possible lack of PPE and staff exposure, modifications are made to these regimens, to minimize risk for all involved in caring for patients with COVID-19.<sup>4</sup> Daily insulin adjustments may be a challenging task. There are no validated protocols for these adjustments. However, an approach based on an extensive literature review is outlined in Fig. 1. Other daily insulin strategies may be followed such as the protocol employed in the RABBIT 2 trial.<sup>9</sup>

The use of non-insulin anti-diabetic medications is another treatment option and should be considered if available. Metformin should be stopped in patients with suspected or COVID-19 positive patients due to the risk of dehydration and lactic acidosis.<sup>2-4</sup> Sulfonylurea therapy needs to be used with caution in patients with declining renal function, the elderly and those prone for hypoglycemia, so it is best to avoid their use in patients infected with COVID-19.<sup>2-4</sup> Sodium-glucose-co-transporter 2 inhibitors carry a risk of dehydration, diabetic ketoacidosis and genitourinary infections, so these drugs should be discontinued in suspected or high risk COVID-19 patients. These drugs include canagliflozin, dapagliflozin, ertugliflozin and empagliflozin.<sup>2-4</sup>



**FIGURE 1.** Inpatient diabetes/hyperglycemia management protocol for non-critically ill patients in COVID-19 era.

**Abbreviations:** A1C, hemoglobin A1c; AC, before meals; BG, blood glucose; BID, twice daily; DKA, diabetes ketoacidosis; DM, diabetes mellitus; HS, bedtime; HHS, hyperosmolar hyperglycemic state; IV, intravenous; NPO, nothing by mouth; SQ, subcutaneous; TDD, total daily dose; Q4h, every four hours; QD, once daily.

\* Degree of hyperglycemia definition adapted from Pasquel 2019.

\*\* Discharge recommendations adapted from Umpierrez 2014.

**Fig. 1 References:**

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**TABLE 1.** Total daily dose (TDD)\* of insulin estimates in non-critically ill patients.

TDD for insulin	Patient group
0.4 unit/kg body weight	- Normal BMI if admission BG 140–200 mg/dl and A1c is controlled
0.5 unit/kg body weight	- Normal BMI if admission BG >200 mg/dl and/or A1c is not controlled - BMI 25–30
0.2–0.3 unit/kg body weight	Conditions with high risk of hypoglycemia: - Age >70 - Liver disease (AKI or CKD especially on HD) - Liver disease - Underweight
0.6 unit/kg body weight	Conditions associated with Insulin resistance: - BMI>30 - Glucocorticosteroids therapy.

*Abbreviations:* A1c, hemoglobin A1c; AKI, acute kidney injury; BG, blood glucose; BMI, body mass index; CKD, chronic kidney disease; HD, hemodialysis.  
\*Total daily dose (TDD) of insulin should be given as 50% basal insulin and, if needed, 50% prandial insulin.

**Table 1 References:**  
1. Magaji V, Johnston JM. Inpatient management of hyperglycemia and diabetes. *Clinical Diabetes*. 2011;29(1):3.  
2. Umpierrez GE, Hellman R, Korytkowski MT, Kosiborod M, Maynard GA, Montori VM, et al. Management of hyperglycemia in hospitalized patients in non-critical care setting: an endocrine society clinical practice guideline. *J Clin Endocrinol Metab*. 2012;97(1):16–38.

Glucagon-like peptide-1-receptor agonists may be associated with dehydration, nausea and vomiting. Since patients infected with COVID-19 may suddenly experience deterioration in their clinical status, it is advisable to stop these agents upon admission to the hospital or continue their use with extreme caution. These agents include albiglutide, dulaglutide, exenatide-extended release, liraglutide, lixisenatide, and semaglutide.<sup>2–4</sup> Based on multiple randomized controlled trials, dipeptidyl peptidase 4 (DDP-4) inhibitors alone or combined with basal insulin could be considered as a safe and effective inpatient

glycemic control strategy for patients with mild to moderate hyperglycemia. These agents include alogliptin, linagliptin, saxagliptin and sitagliptin. DDP-4 inhibitors alone have the potential to decrease hypoglycemia, insulin dose and use, and frequency of blood glucose checks.<sup>10–12</sup> Caution should be used in patients at high risk for heart failure given the FDA warning for this class of medications, although various cardiovascular outcome trials and a recent meta-analysis failed to show a significant increase of heart failure in patients treated with DDP-4 inhibitors.<sup>13</sup>

Experts have suggested that we need to revise guidelines to allow more usage of non-insulin anti-diabetic medications for hospitalized patients.<sup>14</sup> Given the dire situation presented by the COVID-19 global pandemic, we should accelerate this dialog to assess the positive impact that may be provided by utilization of agents requiring less monitoring, fewer healthcare provider contacts, and a lower risk of hypoglycemia. Health care providers and the community as a whole have entered uncharted territory during the COVID-19 pandemic, which has resulted in the development of innovations in delivering medical care while maintaining maximum patient and provider safety, which is a critical and challenging task.

**AUTHOR CONTRIBUTIONS**

All authors contributed equally on this paper.

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**TABLE 2.** Insulin correction scale parameters.

BG mg/dL		Units of insulin		
Daytime: AC	Nighttime: HS	Low dose	Medium dose	High dose
141–170	171–220	1	2	3
171–220	221–270	2	4	6
221–270	271–320	3	6	9
271–320	321–370	4	8	12
321–370	371–420	5	10	15

*Abbreviations:* AC, before meals; BG, blood glucose; HS, bed time.

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