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Inpatient Stroke Management in an Adolescent with Type 1 Diabetes and Home Insulin Pump

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Learning Objectives:

- Highlight the challenges of using home medical devices in hospitalized patients
- Describe when common diabetes technologies – including insulin pumps and continuous glucose monitoring – can be safely utilized in an inpatient setting
- Discuss recommended practices to optimize patient safety when managing hospitalized patients on home insulin pumps

The Case

A 14-year-old girl with a history of type 1 diabetes (T1D) presented to her local emergency department (ED) with two weeks of heavy menstrual bleeding. She was treated with tranexamic acid and oral contraceptive pills and was discharged from the ED. She presented the following day to a different ED with continued menorrhagia, as well as new blurred vision, headache, and left arm numbness. A head CT was normal, and she was transferred to an academic medical center for further management. Shortly after admission, she had worsening of her upper extremity symptoms and brain MRI revealed right middle cerebral artery (MCA) stroke. She was transferred to the pediatric intensive care unit. Further workup led to a diagnosis of antiphospholipid syndrome, and she was treated with aspirin, mycophenolate, hydroxychloroquine, and prednisone. The following week the patient developed new left upper extremity weakness and left upper extremity, chest, and facial paresthesia. Imaging identified a new MCA territory infarct, and enoxaparin treatment was initiated. Additional studies demonstrated splenic and bilateral renal infarcts. She was further treated with high dose steroids and three rounds of plasmapheresis and was discharged home three weeks later.

Throughout her hospitalization, the patient's T1D was managed using her home insulin pump and continuous glucose monitor (CGM). The patient's blood glucose values were routinely above 180 mg/dL during the hospitalization, likely due to her underlying illness, and rose further after glucocorticoid therapy was initiated. In addition, the patient had several instances of insulin pump infusion site leakage and multiple occurrences of incorrect management related to use of her home CGM for calculation of insulin doses. Despite the patient experiencing persistent hyperglycemia, her mother resisted recommendations by the neurology and intensive care services[1,2] to discontinue her pump and initiate intravenous insulin in order to optimize glycemic control.

The Commentary

By Berit Bagley, MSN, Dahlia Zuidema, PharmD, Stephanie Crossen, MD, and Lindsey Loomba, MD

Background

Insulin pump and continuous glucose monitoring (CGM) technology have revolutionized T1D management and are increasingly utilized by patients of all ages.[3,4] Recent data from the T1D Exchange registry estimate that 63% of people with T1D in the U.S. use insulin pumps and 38% use CGM technology, with higher rates at younger ages (e.g. 51% of those <6 years of age).[5] Insulin pumps deliver continuous rapid-acting insulin via a subcutaneous cannula and perform precise dose calculations for patients based on programmed settings that are customized to the individual and the time of day. CGM devices measure glucose levels at frequent (1-5 minute) intervals via a subcutaneous sensor and relay these values to an external device. Newer insulin pumps can receive data from CGMs and employ automated algorithms (called "hybrid closed-loop systems") to adjust insulin delivery in response to glucose levels.

The hospital environment poses unique challenges with respect to diabetes management. Insulin needs can change rapidly with illness, stress, new medications, diet changes, and surgical procedures. Symptoms of hyper- or hypo-glycemia are more difficult to detect in the context of ongoing pain, sedation, or altered mental status. In addition, patients and their caregivers are often frustrated by sharing diabetes

management tasks with medical providers[6-8] who (1) typically have less detailed diabetes knowledge than the patient/caregiver, and (2) must follow hospital protocols that are designed to be maximally safe but minimally flexible for an individual patient's needs. These two issues are both exacerbated when the patient in question uses an insulin pump and/or CGM device since these highly specialized technologies allow improved customization of diabetes management but require additional expertise.

The American Diabetes Association (ADA) recommends that diabetes patients be allowed to use home insulin pumps and CGMs during hospitalizations when possible,[4] and several recent reviews and commentaries offer guidance on when and how this can be achieved safely.[9-11] These publications emphasize proper patient selection – with critical illness and neurologic impairment as contraindications to pump use[10,11] – as well as the necessity of collaboration between patients/families and providers, and the need for standardized hospital protocols.[4,6]

Approach to Optimizing Patient Safety

In the case outlined above, patient/caregiver resistance coupled with provider knowledge deficits, lack of home and hospital technology integration, and inadequate protocols contributed to persistent hyperglycemia. Additionally, insulin pump infusion site leakage occurred several times, possibly due to improper insertion technique or the location of placement. Although the consulting neurologist recommended keeping glucose levels <180 mg/dl and transitioning from insulin pump to an intravenous insulin drip,[1,2] the patient's mother was resistant to this recommendation. Patients with T1D are accustomed to knowing more about diabetes technology than many of their health care providers and as a result may be skeptical about inpatient recommendations for changes.[7,12] Coupled with and influenced by the family's preferences, care providers in this case did not seek consultation from diabetes experts until many days after the patient's admission. Technology limitations also contributed to this patient's CGM; device data did not interface with the hospital electronic health record (EHR), leading to inefficiencies and potential for error. Although an insulin pump protocol existed at the hospital, provider awareness of it was limited and the paper protocol form was not yet integrated with the EHR. Finally, a CGM policy was not in place, and there was widespread misunderstanding among providers about how CGM use alters routine care.

Patient Involvement and Provider Education

Safe inpatient insulin pump use requires partnership between the medical team and the patient/family. Upon admission, it must be decided whether the patient is safe to stay on his/her pump during hospitalization. Contraindications to insulin pump therapy – including critical illness, prolonged surgical procedures, diabetic ketoacidosis or hyperosmolar hyperglycemic syndrome, altered mental status, suicide risk, and lack of home insulin pump supplies[10] – should be discussed frankly with the patient/family and among providers. Shared decision making with the patient is imperative.[13] Assessment of patient ability is also important as patients who appear to be appropriately using an insulin pump on an outpatient basis may in fact be unable to demonstrate critical pump skills during a hospitalization.[14] Disparities in technology use exist[15,16] and cultural barriers that contribute to suboptimal glycemic control in minority populations (such as language skills) should be recognized.

The attending physician should decide whether to continue insulin pump therapy in collaboration with the patient's endocrinologist or diabetes team, who should be consulted at the time of admission[17]. If pump therapy is continued, consultation with an endocrinologist and/or diabetes education specialist is necessary to interrogate the insulin pump and to recommend any needed changes to the patient's insulin doses in the context of current health and expected plan of care. Due to greater diabetes literacy, the diabetes specialist can often help the patient/family establish trust in the overall care plan and understand glycemic goals for the hospitalization[17,18]. The patient should acknowledge the responsibilities of continued pump use in an inpatient setting via a signed agreement[19]. The Joint Commission's "Speak Up" campaign emphasizes the importance of patient self-advocacy and outlines ways in which patients may help optimize their inpatient care.[20] However, provider awareness of the policy was apparently limited, highlighting the importance of effective communication around institutional policies.

Many physicians, pharmacists, and nurses are unfamiliar with diabetes technology and therefore require additional education to care for patients using these devices.[4,17] Due to rapidly evolving technology and relatively low (though increasing) numbers of patients using them, it is difficult for inpatient pediatric providers to gain proficiency in managing insulin pumps and CGMs. Based on the experiences of these authors, it typically falls on the patient/family and consulting diabetes specialist to provide this education. In addition to providing training related to diabetes technology use, the diabetes specialist must also record the pump settings for documentation in the medical chart and discuss how typical diabetes protocols and documenting practices should be altered for use of a pump (see next section). From the perspective of these authors, one alternate approach might be to consider a specialized unit for all patients using diabetes technology. This would allow for specialization of bedside nurses (who would gain proficiency with diabetes technology and expertise in recognizing and managing common problems).

Protocols and Technology

A hospital-wide insulin pump policy and standardized insulin pump order set can help facilitate safe insulin pump use during a hospitalization.[10,17,21] The patient should sign a consent form indicating agreement to follow guidelines and should keep an updated blood glucose log at the bedside. Hospitals do not typically stock pump or CGM supplies[11], and thus the patient should be responsible for bringing them from home. If a patient has an immediate need for a particular supply item (i.e. due to a bad site or broken reservoir), care may be affected due to lack of availability. Ideally, patients would be informed of this issue upon admission and policies for urgently replenishing supplies should be developed.

Inpatient CGM use has theoretical advantages over point-of-care blood glucose monitoring, particularly with regard to early recognition of hypoglycemia.[10] However, there are currently insufficient data on clinical outcomes and safety to recommend widespread CGM use in hospitalized patients.[22,23] Even if the patient uses a CGM, point-of-care blood glucose values measured with a hospital-supplied blood glucose meter are typically necessary for documentation in the EHR and for insulin dosage decision-making in hospitalized patients. In patients using an insulin pump, all bolus doses administered through the pump must be communicated to the medical team and documented clearly in the medical record. Policies detailing how and when self-administered medications are documented in the EHR are essential for safe care.

Several institutions have integrated computerized insulin pump protocols into their EHR[19], which has the potential to improve outcomes and reduce errors related to insulin pump management in hospitalized patients. This will be increasingly important as more patients utilize CGMs and hybrid closed-loop systems moving forward. The desire to achieve tight glycemic control may favor continuing these technologies in the hospital, but the potential for errors will increase if data from these devices cannot be accessed or understood by inpatient medical teams.

Take-Home Points

- Decisions about use of home diabetes devices during hospitalization should be made in consultation with a diabetes specialist, the patient/family, and published guidelines.
- When insulin pumps and/or CGMs are used during hospitalizations, the inpatient medical team will require additional education about these devices.
- Use of standardized protocols, order-sets, and clear documentation practices can minimize the risks for confusion and errors in medical management.
- Daily communication about the goals of therapy can reduce patients' and caregivers' resistance to changes in home insulin regimens.

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