Continuous Glucose Monitoring in Small Animals

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KEYWORDS

• Diabetes mellitus • Continuous glucose monitoring systems
• Self-monitoring of blood glucose • Interstitial fluid • Subcutaneous • Cat • Dog

KEY POINTS

- Continuous glucose monitoring systems have proved to be accurate in small animal patients for monitoring sick/hospitalized and long-term stable diabetic patients.
- The most important advantage of continuous glucose monitoring over intermittent blood glucose measurements is that it facilitates detection of brief periods of hypoglycemia and provides information overnight. A greater number of data points are obtained over a longer time frame allowing for identification of asymptomatic hypoglycemia and Somogyi phenomena that may be missed with traditional monitoring. Monitoring overnight aids in the identification of nocturnal hypoglycemia.
- Other advantages include that it is less time consuming for staff compared with traditional monitoring; reduces patient stress and stress-related hyperglycemia; reduces the frequency of venipuncture and duration of indwelling catheterization; and affords the ability to make adjustments to treatment plans that may not be indicated based on traditional glucose monitoring methods.
- Disadvantages include the initial cost associated with purchasing a system; limited recording range of 40 to 400 mg/dL (2.2–22.2 mmol/L) for the MiniMed Gold, Guardian Real-Time, i-Pro, Seven Plus, and FreeStyle Navigator, and 20 to 600 mg/dL (1.1–33.3 mmol/L) for the GlucoDay; difficulty initializing and calibrating when glucose values are outside the recording range; limited wireless range for the Guardian Real-Time of only 1.5 m; lack of accuracy in dehydrated, hypovolemic, or shock patients; and lag time that may be seen between changes in plasma and interstitial glucose.

INTRODUCTION

Continuous glucose monitoring systems were initially developed for human use as an alternative to traditional blood glucose monitoring methods. Their primary use has been in the monitoring of hospitalized patients, both diabetic and nondiabetic, and

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in self-monitoring of blood glucose. The goals of their use in hospitalized patients are to identify and promptly resolve hyperglycemia and hypoglycemia, which could affect morbidity and mortality, and reduce the need for frequent blood sampling. The goals of their use in self-monitoring of blood glucose are to improve glycemic control, prevent hyperglycemia and hypoglycemia, and thus delay the onset of diabetic complications and improve quality of life. Similar benefits can be achieved in veterinary patients. The use of continuous glucose monitoring systems in veterinary medicine is fairly new, but its use has increased over the past 10 years, with improved technology and veterinarian experience.

Several systems are available for human diabetic patients and some have been used in veterinary patients. These monitors differ in the method used to measure glucose and in various other features that are reviewed later in this article.

PATIENT GROUPS THAT BENEFIT FROM CONTINUOUS GLUCOSE MONITORING

Critical Care (Sick/Hospitalized Diabetic and Nondiabetic Patients): Usefulness

Diabetic cats and dogs are often hospitalized for treatment of illness both unrelated to, and as a complication of, their diabetes. Although the incidence of diabetic ketoacidosis in veterinary patients is unknown, it is recognized as a common life-threatening endocrine disorder in both cats and dogs[1–4]; 1 study found that 62% of cats with ketoacidosis were newly diagnosed diabetics.[1] Any concurrent illness in diabetic patients that causes inappetence, anorexia, or vomiting is rapidly complicated by dehydration, depression, and ketosis. Most diabetic cats that present with diabetic ketoacidosis have at least 1 concurrent disease; liver disease and pancreatitis are the most common.[1] In cats, diabetes mellitus is more commonly a sequela of pancreatitis rather than a risk factor for its development. An evaluation of pancreatitis in cats revealed that only 3% of cats with acute pancreatitis and 15% of cats with chronic pancreatitis had concurrent diabetes mellitus.[5] This is in contrast to dogs in which diabetes is usually classified as a preexisting condition.[3,6–8] Studies report concurrent pancreatitis in 13% to 36% of diabetic dogs[6–8] and in up to 52% of dogs with diabetic ketoacidosis.[3]

Hospitalized diabetics, regardless of the reason for hospitalization, still require insulin therapy. These patients are ideally treated with either a constant rate infusion[9–11] or intermittent intramuscular injections of short-acting insulin.[12] These intensive insulin treatments require close monitoring to ensure appropriate control of hyperglycemia and ketosis, while preventing complications caused by overly rapid correction of hyperglycemia, such as cerebral edema[2,13,14] or insulin-induced hypoglycemia. Such is also the case for nondiabetic patients at risk for altered glucose homeostasis, which includes critical care patients with a variety of conditions[15] including trauma, sepsis, the systemic inflammatory response syndrome,[16–18] portosystemic shunt,[19,20] insulinoma,[21] and liver failure,[22] as well as pediatric patients.

In human intensive care units, hyperglycemia occurs in up to 90% of all critically ill patients and is associated with increased morbidity and mortality.[23–26] The prevalence of hyperglycemia in critically ill nondiabetic cats has not been reported, although in dogs it is less frequent than reported for humans; in 1 study, only 16% of 245 nondiabetic dogs were hyperglycemic.[27] Whether the development of hyperglycemia in critically ill nondiabetic cats and dogs affects survival has yet to be determined. A retrospective evaluation of cats and dogs with head trauma failed to show any correlation between severity of hyperglycemia and survival,[28] although a more recent prospective study on dogs with a variety of critical illnesses did identify a significant association between the severity of hyperglycemia and length of hospital stay and survival.[27]