Insulin Resistance

Discover the latest news on diagnosing and managing this problematic condition.

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Insulin resistance is an emerging problem in the equine industry because it is associated with several equine conditions including Cushing's Syndrome and Equine Metabolic Syndrome, a disease characterized by obesity and recurrent laminitis.

Insulin is a hormone secreted by the ß-cells of the pancreas in response to elevated blood glucose concentrations. For example, after a horse eats a meal high in sugars and starches, blood glucose levels rise, and insulin is released from the pancreas when glucose levels are too high. Insulin's main function is to stimulate tissues such as the skeletal muscle, liver and adipose tissue to take up glucose from the blood, thereby returning blood glucose concentrations back to normal levels. When insulin does not stimulate glucose uptake effectively, it is termed insulin resistance. This condition results in blood glucose concentrations remaining higher than normal (hyperglycemia) and can result in the pancreas secreting more insulin (hyperinsulinemia) in effort to deal with the excess glucose. Furthermore, nutritionists believe hyperglycemia causes inflammatory responses that may be associated with laminitis, and eventually the pancreas may wear out and not be able to produce insulin at all, resulting in diabetes. Although true diabetes is rare in the horse, it has been shown to occur.

Diagnosis of Insulin Resistance

Euglycemic Hyperinsulinemic Clamp (EHC)

Insulin resistance can be diagnosed through quantitatively assessing insulin sensitivity, defined as the ability of insulin to stimulate glucose uptake. In both human and equine scientific studies, the "gold standard" to assess insulin sensitivity is the EHC (See Figures A and B). This test involves the intravenous infusion of insulin into the bloodstream and the concurrent infusion of glucose at a variable rate to maintain normal glucose concentrations. It creates hyperinsulinemia because insulin levels are higher than normal, but it maintains normal blood glucose concentrations or euglycemia. The rate of glucose infusion required to maintain normal glucose levels quantifies insulin sensitivity. For example, a subject that is highly sensitive to insulin will require more glucose to maintain euglycemia because the glucose is rapidly leaving the blood and entering the tissues; a subject that is less sensitive to insulin will require less glucose because it will be staying in the bloodstream and not entering

the tissues. As you might guess, this is not a very practical test for the average horseperson and veterinarian to do because it takes three hours, requires specialized equipment, several blood samples and a very patient horse!
Obesity is associated with insulin resistance, so if you have a horse that is a body condition score of greater than 7, consider swapping dietary sugar for fiber sources. Photo Courtesy of the Hooved Animal Humane Society.

Minimal Model Analysis (MMA)
The MMA also tests insulin sensitivity; glucose and insulin are administered intravenously, and their blood concentrations are then measured and entered into a mathematical model (See Figure C). Although it is a slightly less technical procedure than the EHC, it is still time-consuming and requires a multitude of blood samples.

Glucose Tolerance Test
Another common test is the oral glucose tolerance test. Here glucose is given orally via a nasogastric tube, and blood samples are taken for up to six hours afterwards. However, this test merely examines glucose tolerance. In other words, it cannot distinguish between differences in glucose absorption from the digestive tract, differences in insulin secretion by the pancreas, or the uptake of glucose into tissues by insulin-independent means (See Figure D). Thus, it is not specific enough to quantify insulin sensitivity.

Other Tests
In human medicine, it is common to take a single fasting blood sample to determine blood glucose and insulin concentrations without the influence of food. Although not a specific assessment of insulin sensitivity, the information derived from these tests has been well-correlated to results from the EHC and the MMA. However, in horses, research has shown that a single blood sample is not well-correlated with insulin sensitivity (as determined by either the EHC or MMA). However, preliminary data suggest that if three blood samples were collected on different days (each after horses being without feed for 12 hours) and the averages of the glucose and insulin concentrations found, there would be a stronger relationship to insulin sensitivity than with a single blood sample.
The bottom line is that accurately quantifying insulin sensitivity/resistance is a difficult process. In addition, this field is so new that there is no magic number that indicates "insulin resistant" compared to "normal" from a diagnostic approach.

Causes and Consequences

Insulin resistance is likely caused from a variety of factors, but diets high

in starch and sugar have been shown to decrease insulin sensitivity (increase insulin resistance). These diets are absorbed as glucose when digested, which stimulates insulin production, and nutritionists believe insulin receptors at the tissues may become desensitized or even decrease in number with frequent exposure to insulin caused by sugary foods. Obesity is also associated with decreased insulin sensitivity, as is Cushing's disease and recurrent laminitis. It should be noted that it is unknown if insulin resistance is a predisposing cause or a consequence of these conditions. For example, be aware that although horses with Cushing's Syndrome may also be insulin resistant, a horse that is insulin resistant may not have Cushing's Syndrome. Weight loss and/or exercise have been shown to improve insulin sensitivity.

It is obvious that more research is required in this field to identify simpler tests to diagnose insulin resistance as well as to clarify causes and consequences of this situation. However, if you have a horse that is obese (body condition score greater than 7), and/or suffers from chronic laminitis or Cushing's disease, it would be prudent to adapt this horse to a diet in which more of the energy is coming from fat sources or fiber sources, such as hay, pasture, beet pulp or rice bran, rather than from starch and sugar, such as grains and molasses. More and more feed companies are coming out with nutritionally balanced concentrate mixes that are designed to have lower levels of starch and sugar. If possible, ensuring adequate exercise should also help improve insulin sensitivity in these horses. Check with your veterinarian, equine nutritionist or feed dealer to determine the options that are suitable for your horse.