Recommendations for the Diagnosis and Treatment of Equine Metabolic Syndrome (EMS)
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June 2018

Prepared by the EMS Working Group
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Introduction

Equine Metabolic Syndrome (EMS) is characterized by insulin dysregulation, abnormal adipose tissue distribution, and altered adipokine concentrations. The clinical consequence of EMS is an increased risk of laminitis, although other morbidities also occur. This syndrome results from an interaction between genetics and environment, and the risk of laminitis in the individual animal therefore depends on the relative weighting of these influences. We can identify high-genetic risk animals that develop EMS with only mild environmental influences, and early detection is essential in these animals. Other horses have a lower genetic risk but can develop EMS through exposure to improper environments (diets that provide more calories than an animal requires and are high in non-structural carbohydrates [NSC]). It might therefore be assumed that any horse can develop EMS if pushed far enough in the wrong direction by improper management and exposure to environmental factors. Epigenetic influences on gene expression might also promote or advance the development of EMS.

The Equine Endocrinology Group (EEG) is composed of experts in the field of equine endocrinology who provide advice in the form of written guidelines to help veterinary practitioners diagnose and manage equine endocrine disorders. Guidelines are updated every two years or when new information becomes available and can be found on the EEG web site: [http://sites.tufts.edu/equineendogroup](http://sites.tufts.edu/equineendogroup).

### Table 1 - Definition of Terms

<table>
<thead>
<tr>
<th>Terms</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulin dysregulation (ID)</td>
<td>Any combination of basal (resting) hyperinsulinemia, postprandial hyperinsulinemia (response to oral sugar test or consumed feeds), or insulin resistance. Insulin dysregulation is a central feature of EMS and also occurs in a subset of horses with pituitary pars intermedia dysfunction (PPID) and other conditions such as systemic illness.</td>
</tr>
<tr>
<td>Equine metabolic syndrome (EMS)</td>
<td>A collection of risk factors for endocrinopathic laminitis with ID as the central and consistent feature. Other components of EMS include increased generalized or regional adiposity, weight loss resistance, dyslipidemia, and altered adipokine concentrations. EMS is therefore defined by the presence of ID and commonly one or more of the other risk factors listed above. It is assumed that the risk of endocrinopathic laminitis increases as additional risk factors are encountered.</td>
</tr>
</tbody>
</table>
Insulin dysregulation is detected in equids with EMS and in some with PPID and this is illustrated in the Venn diagram shown in Figure 1.

**Figure 1** - Venn diagram showing the proposed relationships among endocrine disorders discussed in these recommendations. Note that the area of each category within the diagram is purely illustrative and is not intended to be proportionate to the size of the population.

*Note that insulin status is also affected by pregnancy, starvation, and systemic illness.*
Figure 2 - Algorithm for the diagnosis and management of EMS (June 2018)

The following algorithm (Figure 2) outlines the recommended diagnostic and management pathways once ID is diagnosed in both groups of animals.

Horse, pony, or donkey
Presented for evaluation of:
- Laminitis
- Generalized obesity
- Infertility
- Pre-purchase examination
- Contemplating intra-articular or systemic steroids
- Divergent hoof rings
- Regional adiposity
- Wellness examination
- Suspicion of endocrine disease

Test for insulin dysregulation
Refer to Tables 3 and 4

NEGATIVE
- Manage obesity or PPID as appropriate

POSITIVE
- Obese EMS
  - Reduce body fat mass
    - Limit caloric intake
    - Low NCS diet
    - Restricted or zero access to grass
    - Exercise (if feet are stable)
  - Remains obese
    - Levothyroxine
  - Fat loss
- Lean EMS
  - Maintain body condition
    - Low NCS, higher fat, good quality fiber diet
    - Restricted or zero access to grass
    - Exercise (if feet are stable)
- EMS with PPID Obese or Lean
  - Pergolide and diet appropriate for body fat mass
    - Consider other medical treatments for refractory cases
  - Re-test insulin status to assess response
Recommended approach for diagnostic testing

Sample handling & analysis

- Insulin is stable in plasma or serum for at least three days when separated from red blood cells and refrigerated (4°C). Freeze serum or plasma if samples cannot be mailed within this time period. Note that samples may be frozen and thawed once, but multiple freeze-thaw cycles alter insulin concentrations.

- Insulin results vary according to the assay (radioimmunoassay, chemiluminescent assay, or enzyme-linked immunosorbent assay) and analyzer (e.g., Immulite 1000®, Immulite 2000®) used to measure the hormone and cut-off values must be considered accordingly. Contact your diagnostic laboratory to confirm that the insulin assay in use has been validated for use with equine serum/plasma, and that reference intervals are specific to the assay and analyzer that are being used.

Selection of diagnostic tests

- **Two dynamic tests are recommended**: the oral sugar test (OST) and the insulin tolerance test (ITT). The OST is preferred because insulin concentrations measured reflect a more complete sequence of events including digestion and absorption of sugars, incretin hormone responses, and secretion of insulin from the pancreas, whereas the ITT focuses solely upon tissue insulin sensitivity.

- **Oral sugar test**: Advantages of this test include the ready availability of corn syrup, ease of administering corn syrup, and the test’s assessment of insulin responses to ingested sugars. Disadvantages include the requirement for horses to be fasted for 3-12 hours prior to testing and relatively low within-horse repeatability in test results. Variability in results is attributed to multi-factorial influences such as differences in gastric and intestinal transit times, digestion and absorption of sugars, incretin responses and insulin secretion. When monitoring horses over time with this test, binary changes in the positive or negative result and major shifts in insulin concentrations (>30 µU/mL) are clinically significant. Test performance is improved by administering 0.45 mL corn syrup/kg body weight instead of 0.15 mL corn syrup/kg, and this approach is routinely used in the United Kingdom. Oral glucose powder has been used when corn syrup is not available.

- **Insulin tolerance test**: Advantages of the ITT are that this test does not require pre-test fasting and blood glucose concentrations can be measured with a glucometer so preliminary results are available on the farm. The test is less expensive to perform than the OST. Disadvantages include the cost of purchasing insulin and the risk of clinical hypoglycemia developing (although this is unlikely to occur in horses selected for testing on suspicion of ID). A small amount of grain may be fed to the horse or IV dextrose administered immediately after the 30-minute sample is collected to further mitigate hypoglycemia risk.

- **Resting (basal) insulin concentrations**: A single blood sample is collected with the horse in the fed state (hay or pasture, but not grain), and plasma/serum insulin concentrations are measured to detect resting hyperinsulinemia. This approach may be used to assess the insulineemic effect and laminitis risk of the forage component of the current diet.

- **Two-step approach to diagnosing ID**: Testing can be performed in two steps if the owner raises concerns about dynamic tests inducing laminitis. Note: It has been the collective experience of the EEG that dynamic tests cause only transient alterations in glucose and insulin concentrations and do not induce laminitis. The first step is to measure the resting (basal) insulin concentration to screen the horse for hyperinsulinemia and assess laminitis risk. If the resting insulin concentration is normal, a dynamic test must still be performed as a second step because resting measures have low diagnostic sensitivity. Markedly abnormal OST results may be seen in horses with normal resting insulin concentrations. An OST is also recommended when only mild hyperinsulinemia is detected to estimate insulin responses to grazing on pasture or feeds.

- **Blood glucose concentrations**: Diabetes mellitus occurs occasionally in horses and is likely to be detected with higher frequency in equids affected by EMS or PPID. Resting blood glucose concentrations should be measured to detect diabetes mellitus when any of the above tests for ID are performed.

- **Tests that are no longer recommended**: The glucose:insulin ratio and proxy measures of insulin sensitivity are not recommended as substitutes for the OST or ITT; and the combined glucose-insulin test, frequently-sampled intravenous glucose tolerance test, and euglycemic-hyperinsulinemic clamp procedure are considered too complex and expensive for routine clinical use.
Figure 3 - Algorithm for detection of insulin dysregulation (June 2018)

Assess Insulin Status
Refer to Tables 3 and 4

Recommended tests

To screen for ID if concerns about dynamic testing

Dynamic testing ←

Assessment of postprandial insulin response
Withhold feed 3-12 hours

Assessment of tissue insulin sensitivity
Fed (hay) conditions

Oral Sugar Test (OST)
NEGATIVE
(Insulin dysregulation)

POSITIVE
Manage insulin dysregulation (ID)
Refer to Table 6

Insulin Tolerance Test (ITT)
NEGATIVE
Perform OST

POSITIVE
(Insulin resistant)

Manage ID

Resting insulin concentration
Low diagnostic sensitivity

NEGATIVE
Perform dynamic test

POSITIVE
(hyperinsulinemia)

Manage ID

* Consider re-testing and use 0.45 ml/kg dose for OST
# Table 2 - Clinical presentation of Equine Metabolic Syndrome (EMS)

<table>
<thead>
<tr>
<th>Signalment</th>
<th>Clinical Features</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OBESE (TYPICAL) MANIFESTATION OF EMS</strong></td>
<td>Some or all of the following may be present:</td>
</tr>
<tr>
<td>Genetic risk is implied by certain breeds having higher EMS prevalence</td>
<td>Weight loss resistance&lt;br&gt;('Easy keeper'/&quot;Good Doer&quot;)</td>
</tr>
<tr>
<td>Examples of higher genetic risk(^a) breeds:</td>
<td>Laminitis&lt;br&gt;(subclinical or clinical)</td>
</tr>
<tr>
<td>Pony breeds</td>
<td>Creasy neck</td>
</tr>
<tr>
<td>Andalusians</td>
<td>Subcutaneous adipose deposits</td>
</tr>
<tr>
<td>Gaited breeds (e.g., Saddlebreds, Paso Finos)</td>
<td>Clinical problems may be historical or current</td>
</tr>
<tr>
<td>Morgans</td>
<td></td>
</tr>
<tr>
<td>Miniature horses</td>
<td></td>
</tr>
<tr>
<td>Warmbloods</td>
<td></td>
</tr>
<tr>
<td>Uncertain genetic risk: Donkeys(^b)</td>
<td></td>
</tr>
</tbody>
</table>

**LEAN MANIFESTATION OF EMS**

- Genetically-at-risk horse kept in controlled environment
- Laminitis (subclinical or clinical) only

**EMS with PITUITARY PARS INTERMEDIA DYSFUNCTION (PPID)**

- EMS may be historical
- Genetically-at-risk horse that develops PPID (exacerbates insulin dysregulation)

**Clinical signs of EMS**

- (current problem)
- Regional adiposity and/or obesity
- Laminitis

**No clinical signs of EMS currently**

- (historical problem)
- Lean/thin at present

**OTHER CONDITIONS THAT SHOULD PROMPT TESTING FOR ID**

- Diabetes mellitus, metabolic derangements detected during critical care, equine hyperlipemia, infertility, colic caused by a pedunculated lipoma (associated with obesity), preputial/mammary gland edema, or detection of divergent hoof rings. Testing should also be considered prior to intra-articular or systemic corticosteroid administration, or as part of wellness or prepurchase examinations.

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\(^a\) These breeds are overrepresented and there is evidence of a genetic predisposition in Arabian horses. Additional studies are currently being conducted to examine the genetic basis of EMS.

\(^b\) Equine metabolic syndrome is poorly characterized in donkeys because reference intervals for insulin tests are still being determined.
Table 3 - Diagnostic testing: Resting insulin concentrations

<table>
<thead>
<tr>
<th>Procedure</th>
<th>After hay (no grain)</th>
<th>While on pasture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Do not feed grain within 4 hours</td>
<td>Used to assess insulin concentrations during grazing (^d)</td>
</tr>
<tr>
<td></td>
<td>Collect into serum or EDTA tube (check with laboratory)</td>
<td>(assessment of current management)</td>
</tr>
</tbody>
</table>

| Assays used\(^a\)               | Results must be interpreted in the context of the insulin assay used                 |
|                               | (chemiluminescent assay, radioimmunoassay, or ELISA)                                 |

<table>
<thead>
<tr>
<th>Results</th>
<th>Interpretation(^c)</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 20 (\mu U/mL)(^b)</td>
<td>Non-diagnostic</td>
<td>Dynamic test recommended to better assess</td>
</tr>
<tr>
<td>20-50 (\mu U/mL)(^b)</td>
<td>ID suspect</td>
<td>Proceed with ID management</td>
</tr>
<tr>
<td>&gt; 50 (\mu U/mL)(^b)</td>
<td>Insulin dysregulation</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) Assay should be validated for use with equine samples

\(^b\) Cut-off values for Immulite 1000; different values may be required for other assays or analyzers. For example, equivalent Immulite 2000xpi values are 31 and 80 \(\mu U/mL\) for 20 and 50 \(\mu U/mL\), respectively

\(^c\) Quality and NSC content of forages can vary and affect results; cut-off values are only applicable when horses are consuming low-NSC carbohydrate hay

\(^d\) Note that these values reflect the NSC content of the grass being consumed at the time of testing, which can change quickly and significantly over time
### Table 4 - Dynamic insulin tests

<table>
<thead>
<tr>
<th>Oral Sugar Test&lt;sup&gt;a,b&lt;/sup&gt;</th>
<th>Insulin Tolerance Test&lt;sup&gt;b,c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Procedure</strong></td>
<td></td>
</tr>
<tr>
<td>Fast 3-12 hours</td>
<td>Fed (pasture or hay) state. Do not fast</td>
</tr>
<tr>
<td>Administer 0.15 mL/kg corn syrup orally via dose syringe</td>
<td>Collect blood at time 0 and administer 0.10 IU/kg regular (soluble) insulin</td>
</tr>
<tr>
<td>Collect blood at 60 and 90 minutes</td>
<td>Collect blood at 30 minutes</td>
</tr>
<tr>
<td>Measure insulin and glucose</td>
<td>Measure glucose</td>
</tr>
<tr>
<td></td>
<td>Feed meal immediately after last sample</td>
</tr>
<tr>
<td><strong>Interpretation</strong></td>
<td></td>
</tr>
<tr>
<td>&gt; 45 µU/mL is positive&lt;sup&gt;d&lt;/sup&gt;</td>
<td>&lt; 50% decrease in blood glucose concentrations from baseline is consistent with insulin resistance</td>
</tr>
<tr>
<td>Assess baseline (fasting) glucose concentration to detect diabetes melitus (rare)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Alternative tests</strong></td>
<td></td>
</tr>
<tr>
<td>In-feed oral glucose tolerance test (OGTT)</td>
<td>Combined glucose-insulin test (CGIT)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Use of a higher dose of corn syrup (0.45 mL/kg) improves test performance.

<sup>b</sup> United Kingdom/Europe: An insulin cut-off value of 40 µU/mL is used for the 0.45 mL/kg OST when measuring insulin with the chemiluminescent assay and Immulite 1000® (http://liphoequinehospital.co.uk/equine-laboratory/); or 110 µU/mL with the radioimmunoassay.

<sup>c</sup> USA: At the time of writing, cut-off values have not been established for the 0.45 mL/kg OST when using an ELISA to measure insulin.

<sup>d</sup> Note that hypoglycemia is a risk associated with this test. Provide feed after collecting the second blood sample. Administer dextrose solution intravenously if clinical signs of hypoglycemia develop.

<sup>e</sup> Try to minimize stress prior to testing.

<sup>f</sup> When insulin is measured using the radioimmunoassay.
<table>
<thead>
<tr>
<th>Test</th>
<th>Procedure</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adiponectin</td>
<td>Collect blood in serum tube; chill on ice and keep refrigerated</td>
<td>High molecular weight (HMW) adiponectin concentrations &lt; 3.2 µg/mL (ELISA) are consistent with metabolic derangement in adipose tissues and increased risk of laminitis. Total adiponectin concentrations &lt; 2.5 µg/ml (RIA) or &lt; 24 µg/ml (immunoturbidimetric assay) are consistent with EMS.</td>
</tr>
<tr>
<td>Leptin</td>
<td>Collect blood in serum or EDTA tube; keep refrigerated</td>
<td>Consult reference interval provided by laboratory. Higher leptin concentrations are associated with increased adiposity and metabolic derangement. Useful for providing evidence of increased internal adiposity. This hormone is more directly associated with obesity than ID.</td>
</tr>
<tr>
<td>Triglyceride concentrations</td>
<td>Collect blood in serum tube</td>
<td>Consult reference interval for laboratory. Hypertriglyceremia associated with ID and obesity, exacerbated by negative energy balance. Hypertriglyceremia is a predictor of laminitis risk in ponies, with cut-off values of 57 and 94 mg/dL previously reported.</td>
</tr>
</tbody>
</table>

**Potential Future Tests**

Glucose-dependent insulino tropic (poly)peptide (GIP) concentrations, glucagon-like peptide-1 and -2 concentrations, C-peptide concentrations, and genetic and metabolomic testing

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* Lipook Equine Hospital (http://liphookequinehospital.co.uk/equine-laboratory/) offers the HMW adiponectin assay (ELISA)
* Animal Health Diagnostic Center at Cornell University (https://ahdc.vet.cornell.edu/)
Table 6 - Management recommendations for equine metabolic syndrome

**Management and monitoring of EMS**

<table>
<thead>
<tr>
<th>Obese (typical) EMS BCS 6-9/9</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial diet</strong></td>
</tr>
<tr>
<td>Restrict or eliminate grazing and do not feed grain.</td>
</tr>
<tr>
<td>For weight loss, feed grass hay with low NSC content in amounts equivalent to 1.5% of current body weight daily.</td>
</tr>
<tr>
<td>Reassess body weight every 30 days using a weight scale or weight tape and gradually lower to a minimum of 1.2% of body weight as-fed if weight loss resistant. House in a dry-lot or small paddock with a companion. Avoid stress as much as possible.</td>
</tr>
<tr>
<td>NSC analysis of hay recommended, particularly if severe ID is detected. Select hay with NSC content &lt; 10% as-fed if available.</td>
</tr>
<tr>
<td>Soak hay in cold water for 60 minutes before feeding to lower the water-soluble carbohydrate content. *</td>
</tr>
<tr>
<td>Incorporate slow feeder or provide frequent, small meals so that prolonged fasting is avoided.</td>
</tr>
<tr>
<td>Provide a mineral/vitamin/protein ration balancer. Care should be taken to select a ration balancer with low sugar content.</td>
</tr>
</tbody>
</table>

**Maintenance diet**

Restrict grazing and do not feed grain

Maintain on initial hay amount until body condition 5/9 is achieved. Improvement in the values obtained from the same test(s) used to diagnose EMS (OST, ITT, HMW adiponectin, and/or leptin concentrations) is expected when re-tested under similar conditions.

Soak hay (see above)

Provide mineral/vitamin/protein ration balancer

Turnout decision based upon follow-up testing of postprandial insulin response and might include use of a grazing muzzle or other methods to reduce grass consumption.

**Exercise**

Exercise is recommended unless laminitis is present. All levels of exercise are likely to be beneficial for accelerating weight loss in obese animals, but more intense exercise programs may be required to improve insulin sensitivity.

Exercise levels should be incrementally increased over time until the horse is being worked at a canter to fast canter, ridden or unridden, for > 30 minutes per day for > 5 times per week. If heart rate can be monitored, the intensity of exercise should be sufficient to induce rates of 150 to 170 beats per minute.

**Housing**

Stress should be avoided, and the affected horse should be housed in a small paddock with a companion, instead of being confined to a stall. Take precautions to limit stereotypic behavior by using slow feeders. Turnout on pasture is strongly discouraged until the problems of obesity and ID are successfully addressed.
**Management and monitoring of EMS (continued)**

### Obese (typical) EMS

**BCS 6-9/9 (continued)**

#### Medical therapy

**High-dose levothyroxine**

Indications: For cases with weight loss resistance (no documented response after a minimum of 30 days on weight loss diet) or for accelerated management of obesity in acute laminitis cases.

Available in the USA, but high cost restricts use in the UK or Europe. Administer levothyroxine at a high dose of 0.1 mg/kg (48 mg or 4 teaspoons of the powdered product for a 500-kg horse) daily in the feed or by mouth while also controlling caloric intake. Gradually reduce the dose and discontinue treatment after weight loss achieved or after 3-6 months of therapy.

**Metformin hydrochloride**

Indications: For animals with persistent hyperinsulinemia, even after management changes have been followed. Metformin is sometimes prescribed for the first two weeks when a horse is transitioned back to pasture, but additional research is required to assess this approach.

Administer 30 mg/kg metformin hydrochloride in the feed or by mouth, ideally 30 minutes prior to feeding or turnout, up to 3 times daily. Metformin can also be administered at a higher dose of 50 mg/kg, but oral irritation may occur at this dose. Check insulin concentrations 2 hours post-feeding before and 7 days after initiating metformin treatment because metformin does not improve insulin status in all cases.

**Medical treatments in development**

- Sodium-glucose co-transporter 2 (SGLT2) inhibitors (canagliflozin and velagliflozin) and thiazolidinediones (pioglitazone) are currently being evaluated as drugs for medically managing ID in horses.

#### Foot care

Routine hoof care is essential in all cases. Laminitis can occur without inducing easily detectable lameness, and radiographs are recommended to identify structural changes.

### Lean EMS

**BCS 4-5/9**

#### Diet

Maintain on low-glycemic diet, with severity of restriction dependent on postprandial insulin response. Analyze NSC content of hay if severely affected. Provide diet with low-NSC, high-fat, and add calories in the form of high-quality fiber content such as beet pulp or soy hulls.

Provide mineral/vitamin/protein ration balancer.

#### Exercise

As above.

#### Medical

Levothyroxine not recommended, as weight loss is not required.

### EMS with diagnosed PPID

Follow appropriate recommendations from above, depending upon body condition.

#### Medical

Administer pergolide [Prascend® (pergolide tablets); Boehringer-Ingelheim Vetmedica, Inc.]; refer to EEG Recommendations on PPID.

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* Acknowledging that this will not reliably lower the NSC content to <10% in all hays."
### Consideration of pituitary pars intermedia dysfunction (Cushing’s disease) status

Refer to the most recent Equine Endocrinology Group recommendations on diagnosing and managing PPID in horses: https://sites.tufts.edu/equineendogroup/

<table>
<thead>
<tr>
<th>Consideration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
</tr>
<tr>
<td>EMS affects horses across a wide range of ages</td>
</tr>
<tr>
<td>PPID is a common comorbidity in horses above 10 years, and the likelihood of PPID increases as the age of the horse increases.*</td>
</tr>
<tr>
<td><strong>Impact on ID</strong></td>
</tr>
<tr>
<td>PPID is an exacerbating factor for ID speculated to be a consequence of hormone products secreted from the pars intermedia.</td>
</tr>
<tr>
<td>Age alone alters insulin dynamics and responses to different diets, with higher insulin secretion and lower insulin sensitivity detected in aged horses.10,11</td>
</tr>
<tr>
<td><strong>Diagnostic testing</strong></td>
</tr>
<tr>
<td>Early-affected horses should undergo thyrotropin-releasing hormone (TRH) stimulation testing (test results are difficult to interpret in late summer-fall).</td>
</tr>
<tr>
<td>When performed at the same time as diagnostic tests for ID, the TRH stimulation test is performed before, but not during or after the OST.12</td>
</tr>
<tr>
<td>A combined insulin tolerance test/TRH stimulation test has recently been developed and for this test, insulin and TRH are administered together as a single IV injection (personal communication; François-René Bertin).</td>
</tr>
<tr>
<td>Basal plasma ACTH concentrations are measured for more advanced cases. Detection of a high ACTH concentration confirms the diagnosis of PPID, but horses with suggestive clinical signs and negative results should undergo TRH stimulation testing.</td>
</tr>
<tr>
<td><strong>Management</strong></td>
</tr>
<tr>
<td><strong>Diet:</strong> Based upon the postprandial insulin response. An OST or oral glucose test is recommended for all horses diagnosed with PPID.</td>
</tr>
<tr>
<td><strong>Exercise:</strong> Refer to Table 5.</td>
</tr>
<tr>
<td><strong>Medical:</strong> Administer pergolide [Prascend* (pergolide tablets); Boehringer Ingelheim]</td>
</tr>
<tr>
<td><strong>Comorbidities:</strong> May require management of other medical problems related to PPID and age, including bacterial infections, dental disease, organ dysfunction, and parasitism.</td>
</tr>
<tr>
<td><strong>Critical illness:</strong> Insulin dysregulation and PPID are complicating factors in patients with critical illness and may predispose affected patients to hyperglycemia and hypertriglyceridemia. Endocrine system decompensation may adversely affect treatment outcomes.</td>
</tr>
</tbody>
</table>

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* Although a causal relationship between EMS and PPID has been suggested, there are currently no published research studies evaluating their association.

**Disclosures**

Andy Durham and Lisa Tadros are affiliated with the Liphook Equine Hospital and the Veterinary Diagnostic Laboratory at Michigan State University, respectively and both institutions offer endocrine testing.

Boehringer Ingelheim Vetmedica, Inc. facilitates the development of EEG guidelines by supporting travel expenses for participants but does not influence the recommendations made by the group.
References


