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Descriptive Clinical Report

Severe hypertriglyceridaemia in horses and ponies with endocrine disorders

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Summary

Reasons for performing the study: Severe hypertriglyceridaemia in horses and ponies with endocrine disorders has been reported anecdotally but has not been documented in the literature.
Objectives: To describe historical and clinicopathological findings as well as progression and outcome in horses and ponies with severe hypertriglyceridaemia (serum triglyceride concentration >5.65 mmol/l) secondary to an endocrine disorder that were otherwise apparently healthy.
Methods: Cases from 6 participating institutions were identified and case details extracted from the medical records.
Results: Case details of 3 horses and 4 ponies were available. Presenting complaints included weight loss despite good appetite in 4 animals, while in 3 hypertriglyceridaemia was identified incidentally. All animals were bright and alert and showed a normal or increased appetite. Serum triglyceride concentrations ranged from 10.5 to 60.3 mmol/l. Other abnormalities included hyperglycaemia in 6 animals, suspected insulin resistance and mild to severe increases in hepatic enzyme activities. In 2 animals, moderate hepatic lipidosis was confirmed histologically. Three horses and 3 ponies were diagnosed with pituitary pars intermedia dysfunction based on clinical signs and basal adrenocorticotropic hormone (ACTH) concentrations or dexamethasone suppression test results. In 5 of these, *type 2* diabetes mellitus was also confirmed, while one pony suffered from *type 2* diabetes mellitus without concurrent pituitary pars intermedia dysfunction. Laboratory abnormalities improved in 4 animals with treatment (pergolide and/or insulin), in one horse specific treatment was not attempted, and in 2 ponies treatment was impaired by the owner or only partly effective. In one of the latter cases, biochemical abnormalities persisted for 7 years without apparent ill effects.
Conclusions and potential relevance: Horses and ponies may develop severe hypertriglyceridaemia secondary to endocrine disorders that are associated with insulin resistance. Hypertriglyceridaemia can resolve with treatment of the endocrinopathy. Although biochemical evidence of hepatic compromise was present, clinical abnormalities were not noted in these animals.

Keywords: horse; pituitary pars intermedia dysfunction; diabetes mellitus; hyperlipaemia; hypertriglyceridaemia; hepatic lipidosis

Introduction

Hypertriglyceridaemia secondary to inappetence and systemic disease has been described in horses and, more commonly, in pony and miniature breeds and donkeys [1–7]. Occurrence of hypertriglyceridaemia is generally considered a serious complication that can significantly worsen the prognosis and that warrants immediate treatment. Anecdotally, extremely high serum triglyceride (TG) concentrations have been observed in horses with pituitary pars intermedia dysfunction (PPID); however, to the authors' knowledge this abnormality has not been documented in the literature. The objective of this case series was to describe historical and clinicopathological findings as well as progression and outcome in otherwise apparently healthy horses and ponies in which severe hypertriglyceridaemia (defined as TG concentrations >5.65 mmol/l) [8] was documented in association with an underlying endocrine disorder.

Case 1

A 23-year-old Thoroughbred cross mare was presented to The Royal Veterinary Hospital Equine Referral Hospital for investigation of polyuria/polydipsia, severe hypertriglyceridaemia (16.0 mmol/l) and weight loss that had occurred over a 3-week period despite an increased appetite. The owner also reported that the mare had developed a long and fluffy hair coat during the preceding winter. On presentation, the mare was in poor body condition (weight 550 kg, body condition score [BCS] 3/9) [9] but was otherwise bright, alert and responsive. Physical examination was normal, with the exception of a mildly increased respiratory rate and end-expiratory wheezes on rebreathing examination, attributed to previously diagnosed recurrent airway obstruction. Ultrasonographic examination of the thorax and abdomen and peritoneal fluid analysis were unremarkable. Repeat biochemistry identified persistent hypertriglyceridaemia (16.26 mmol/l, reference range 0.17–0.46 mmol/l) and mild increases in hepatic enzyme activities (gamma-glutamyl transpeptidase [GGT] 54 u/l, reference range 5–34 u/l; and sorbitol dehydrogenase [SDH] 10.4 u/l, reference range 1.8–6.7 u/l). Haematology was normal. Blood glucose concentration was measured on several occasions in a fasted and fed state and was persistently high, ranging from 16 to 17 mmol/l (reference range 3.5–6.0 mmol/l). Creatinine and blood urea nitrogen [BUN] concentrations were normal, and urine analysis revealed a normal specific gravity and a large amount (4+) of glucose on reagent strip analysis. Fasted insulin concentration was within normal limits (52 mu/l, reference range 8.9–65 mu/l) despite hyperglycaemia. Plasma adrenocorticotropic hormone (ACTH) concentration was increased (126 pg/ml, seasonally adjusted reference range <29 pg/ml), supporting a diagnosis of PPID with *type 2* diabetes mellitus. Initially, treatment with i.v. glucose was pursued to counteract hypertriglyceridaemia; however, even a modest rate of glucose administration (1 mg/kg bwt/min) resulted in worsening hyperglycaemia, and this treatment was discontinued. The horse was discharged from the hospital on treatment with pergolide (1.8 μg/kg bwt *per os* every 24 h) and

metformin (20 mg/kg *per os* every 12 h). On subsequent examination by the referring veterinarian one month later, the mare had gained weight (BCS 5/9), the polyuria and polydipsia had resolved, TG and plasma glucose concentrations were normal (0.4 and 6.5 mmol/l, respectively) and plasma insulin and ACTH concentrations had decreased to 21 mu/l and 58 pg/ml, respectively. Another one month later, the plasma ACTH concentration had decreased to 51.7 pg/ml. The mare remained in good health until she succumbed to colic 9 months later; a *post mortem* examination was not performed.

Case 2

A 22-year-old Arabian gelding was presented to The Ohio State University, College of Veterinary Medicine for evaluation of weight loss and increased hepatic enzyme activities. The gelding had lost approximately 70–100 kg over the preceding 3–4 months despite having a normal appetite. The horse had previously been diagnosed with recurrent airway obstruction, and treatment with pergolide (2.6 μg/kg bwt *per os* every 24 h) had been initiated approximately 12 months prior to referral due to clinical signs consistent with PPID (moderate hypertrichosis and epaxial muscle atrophy). On presentation, the gelding was in poor body condition (weight 376 kg, BCS 3/9) but was otherwise bright, alert and responsive. With the exception of increased heart and respiratory rates (60 beats/min and 32 breaths/min, respectively), physical examination findings were unremarkable, as were haematology, plasma fibrinogen concentration, a coagulation profile, faecal worm egg count and thoracic ultrasonography. Abdominal ultrasonography revealed suspected moderate hepatomegaly. Clinical biochemistry identified an increased fasted glucose concentration (21.3 mmol/l) yet a normal fasted insulin concentration (16.7 mu/l, reference range <20 mu/l), increased hepatic enzyme activities (GGT 2164 u/l; SDH 263 u/l; alkaline phosphatase [ALP] 1747 u/l, reference range 80–186 u/l; aspartate aminotransferase [AST] 1251 u/l, reference range 170–370 u/l) and serum bile acid (103 μmol/l, reference range 4–12 μmol/l) and TG concentrations (10.5 mmol/l). Creatinine and BUN concentrations were measured on 6 occasions and remained normal. Insulin resistance, identified by minimal model kinetics of a frequently sampled i.v. insulin and glucose tolerance test and an increased ACTH concentration (124 pg/ml, nonseasonally adjusted reference range 9–35 pg/ml; samples were obtained in September), supported a diagnosis of PPID with suspected *type 2* diabetes mellitus. A liver biopsy revealed marked diffuse hepatocellular vacuolar changes consistent with hepatic lipidosis. No bacterial growth was reported on culture of the liver biopsy sample. The horse was hospitalised, and treatment with regular and protamine zinc insulin (PZI) for 10 days (Day 1, 40 iu regular insulin i.m. once; Days 2–4, 60 iu regular insulin i.m. every 4 h; Days 5–10, 120 iu PZI insulin i.m. b.i.d.; Day 11, 120 iu PZI i.m. once) and pergolide (5 μg/kg bwt *per os* every 24 h for 6 days, then 8 μg/kg bwt *per os* every 24 h) was initiated. On discharge from the hospital 13 days following admission, the gelding had gained 20 kg and clinical biochemistry values had improved (TG concentrations 1.3 mmol/l; fasted glucose concentration 11 mmol/l; GGT 1394 u/l; SDH 149 u/l; ALP 1144 u/l; AST 1058 u/l; serum bile acids 38 μmol/l). After 6 months of continued treatment with pergolide (8 μg/kg bwt *per os* every 24 h) there was an improvement in hypertrichosis, and one year after hospital discharge, the gelding was reported to have an excellent appetite and had gained further weight; however, the epaxial muscle atrophy remained unchanged.

Case 3

A 32-year-old Arabian gelding (weight 370 kg, BCS 3/9) was donated to Michigan State University in August for inclusion into a research study. The horse had a history of weight loss that occurred during the preceding winter despite the horse having a good appetite. The gelding also exhibited clinical signs of PPID (hypertrichosis, epaxial and rump muscle wasting and excessive sweating). The horse was otherwise in good health, and physical examination and haematology findings were unremarkable. The serum was grossly lipaemic, and serum biochemistry revealed mild hypoalbuminaemia (31 g/l, reference range 36–48 g/l), hyperglycaemia (16.9 mmol/l) and severe hypertriglyceridaemia (25.9 mmol/l). Creatinine and BUN concentrations were measured twice and were within the reference range. PPID was confirmed by an overnight dexamethasone suppression test. Cortisol concentrations decreased from 111 nmol/l predexamethasone (40 μg/kg bwt i.m.) administration to 94 nmol/l 19 h post administration. Repeated serum biochemistry 38 days later showed mild worsening of hypoalbuminaemia (27 g/l), increased GGT activity (109 u/l), persistent hyperglycaemia (13.3 mmol/l) and hypertriglyceridaemia (27.4 mmol/l). The gelding remained bright, with a good appetite, and no further weight loss occurred until the horse was subjected to euthanasia 1.5 months after admission as dictated by the protocol of the research study. *Post mortem* examination confirmed PPID (pituitary gland weight 5.8 g and PPID *grade 5/5*; pituitary weight/body weight, 15.7×10^{-6} g, range in normal animals, $4.2–8.5 \times 10^{-6}$ g) [10,11], but no abnormalities of the liver or other tissues were reported.

Case 4

Clinicians at the University of Minnesota Equine Center were consulted over a period of 7 years on management of a pony mare with persistent hypertriglyceridaemia, hyperinsulinaemia and hyperglycaemia. The abnormalities had been attributed to PPID. On initial presentation, the mare was 24 years of age (weight 263 kg, BCS 5/9) and had exhibited slowly progressive hypertrichosis, polyuria, polydypsia and loss of muscle mass for 10 years prior. Two weeks prior, PPID was diagnosed by dexamethasone suppression test and gross lipaemia was also noted despite a good appetite and absence of other clinical signs of disease. Following introduction of treatment with compounded pergolide (3.8 μg/kg bwt *per os* every 24 h), the pony became depressed and anorexic and developed a heart murmur. Laboratory abnormalities identified by the referring veterinarian included increases in hepatic enzyme activities (ALP 204 u/l; AST 693 u/l; GGT 46 u/l; SDH 10 U/l), hyperglycaemia (14.3 mmol/l) and hypertriglyceridaemia (28.9 mmol/l), and the mare was referred. Physical examination on admission was unremarkable apart from signs of PPID, but the mare was inappetent and previously identified laboratory abnormalities persisted (TG 19.2 mmol/l; blood glucose concentration 13.8–15.5 mmol/l). Additionally, hyperinsulinaemia (260 mu/l, reference range 10–30 mu/l) was identified. Increases in liver enzyme activities had worsened (ALP 272 u/l; AST 1291 u/l; GGT 120 u/l; SDH 443 u/l); a liver biopsy showed mild lipid deposition, and a bacterial culture was negative. Treatment included regular insulin (constant rate infusion 0.06 u/kg bwt/h i.v. followed by bolus administrations of 0.7 u/kg bwt i.m. every 2 h at decreasing frequency), heparin (100 u/kg bwt s.c. every 12 h) and enteral feeding until the pony became appetent and was discharged on continued insulin therapy. On second presentation 6 weeks later, the mare was clinically improved and eating well, but gross lipaemia was still evident and laboratory tests revealed continued increase of insulin (>300 mu/l), glucose (15.5 mmol/l) and TG (9.4 mmol/l) concentrations. The owner allowed reinitiation of pergolide therapy at that time (0.7 μg/kg bwt *per os*), but in subsequent years the mare was consistently underdosed due to the owner's concern about the possibility of an adverse reaction. Clinical signs of PPID did not resolve on this dosing regimen, and glucose (8.3–15.5 mmol/l), insulin (220–280 mu/l) and TG (5.8–8.1 mmol/l) concentrations remained increased over the next year, but the mare remained bright and active, with a good appetite.

One year following her initial presentation, the mare developed depression and inappetance in association with dental disease (malocclusions and gingivitis) and mild bacterial pneumonia. These were initially addressed by her regular veterinarian, but laboratory values also showed worsening of the hyperglycaemia (16 mmol/l), hyperinsulinaemia (300 mu/l) and hypertriglyceridaemia (60.3 mmol/l). The pergolide dose was increased to 1.5 μg/kg bwt, and the mare was hospitalised for management with insulin, heparin and enteral feeding until her appetite returned. Again the mare stabilised and was discharged to her owner's care, though hypertriglyceridaemia persisted (29 mmol/l). In the second year of the consultation period, the mare remained bright, with a good appetite and body condition and continued hypertrichosis. Hyperglycaemia (5 measurements; 10.5–13.5 mmol/l) hyperinsulinaemia (3 measurements; 176–>300 mu/l) and hypertriglyceridaemia (9 measurements; 5.1–32.3 mmol/l) persisted despite intermittent insulin therapy. When values increased over the course of the year and gross

lipaemia developed, pergolide therapy was increased to 2 μg/kg bwt and then 4 μg/kg bwt *per os* every 24 h, and long-acting insulin was substituted for regular insulin.

Over the next 5 years, the mare remained stable, with a good appetite and body condition despite continued clinical signs of PPID. Endogenous ACTH values were measured on 6 occasions during all seasons during this period and ranged between 306 and 810 pg/ml (nonseasonally adjusted reference range 8–30 pg/ml), and the pergolide dose was increased to 6 μg/kg bwt. Serum glucose was measured on 7 occasions and ranged between 12.4 and 16.8 mmol/l, while serum insulin was measured on 5 occasions and declined over time from 84 to 11.8 mu/l. Serum TG fluctuated over time (7 measurements; 5.4–28.2 mmol/l); the highest TG values occurred in association with minor illnesses and injuries causing reduced feed intake. Creatinine and BUN concentrations were assessed on multiple occasions and remained normal. Seven years following the mare's initial presentation, she represented with endotoxaemia related to presumptive enterocolitis and she was subjected to euthanasia. A *post mortem* examination was not carried out.

Case 5

A 12-year-old Shetland cross mare was presented for a routine follow-up examination. The mare had experienced a transient episode of anorexia, lethargy and tachypnoea 6 weeks prior to presentation. The problem had resolved within 48 h without treatment, but hyperglycaemia, gross lipaemia and increased GGT activity had been noted at the time; creatinine and BUN concentrations were normal. On physical examination, the mare was bright, alert and responsive but mildly overweight (BCS 6/9). All other physical and haematology findings were normal. However, repeated serum biochemistry demonstrated severe hypertriglyceridaemia (26.7 mmol/l), hyperglycaemia (14.6 mmol/l) and hyperinsulinaemia (56 mu/l, reference range 7–51 mu/l). Further abnormalities included increased cholesterol concentration (8.1 mmol, reference range 2.1–3.5 mmol/l) and increased activities of GGT (113 u/l), ALP (307 u/l) and AST (506 u/l). Bile acid concentration was normal. The mare was treated with metformin (15 mg/kg bwt *per os* every 12 h), but after 10 days of treatment the hyperglycaemia and hypertriglyceridaemia persisted (14.6 and 15.6 mmol/l, respectively). Seven weeks after the initial assessment, fasting hyperglycaemia (13.4 mmol/l) persisted, with an inappropriately low insulin concentration (18.9 mu/l, reference range <20 mu/l) and glucosuria (4+), although ACTH concentration was normal (22 pg/ml, seasonally adjusted reference range <41 pg/ml). *Type 2* diabetes mellitus with pancreatic β cell dysfunction was confirmed by a combined glucose–insulin tolerance test [12] after withdrawal of all medications. This demonstrated baseline hyperglycaemia (12.2 mmol/l) with normo-insulinaemia (17 mu/l), failure of the glucose to return to baseline within 150 min, and relatively modest insulin response at 45 min (35.9 mu/l). Treatment with PZI (0.4 u/kg bwt s.c. every 12 h) failed to control the hyperglycaemia, but serum triglyceride concentration decreased to 4 mmol/l. Treatment was continued for 6 weeks, during which serum triglyceride concentrations fluctuated between 1.5 and 5.0 mmol/l and serum GGT activity decreased to 53 u/l; plasma glucose concentrations did not change significantly. Insulin treatment was slowly decreased, and serum triglyceride concentrations remained stable between 0.8 and 2.6 mmol/l. Insulin was discontinued, and serum triglyceride concentrations remained between 1 and 2 mmol/l for a further 4 weeks when regular monitoring was discontinued. During a follow-up examination 2.5 months after discontinuation of insulin therapy, hypertriglyceridaemia (25.6 mmol/l) and hyperglycaemia (13.9 mmol/l) had recurred in the face of a normal insulin concentration (27 mu/l), although the pony remained apparently healthy. Three years after initial examination, the pony was reported to be healthy and performing well, with a normal appetite, despite discontinuation of treatment; triglyceride concentration was determined once and revealed a mild increase (1.38 mmol/l).

Case 6

A 17-year-old Welsh pony gelding (weight approximately 333 kg, BCS 4.5/9) was presented for investigation of diarrhoea and laminitis. Underlying PPID was suspected and supported by an increased ACTH concentration (38.1 pg/ml, seasonally adjusted reference range <29 pg/ml). At the time, serum TG (1.8 mmol/l), fasted glucose (8.3 mmol/l) and insulin (302 mu/l, reference range <20 mu/l) concentrations were also increased, supportive of *type 2* diabetes mellitus. Treatment with pergolide (3 μg/kg bwt *per os* every 24 h) and metformin (20 mg/kg bwt *per os* every 12 h) was initiated. One month later, the diarrhoea had resolved and the laminitis improved; ACTH, glucose and insulin concentrations had decreased (22.2 pg/ml, 6.2 mmol/l and 89.4 miu/l, respectively), while TG concentrations remained unchanged (1.8 mmol/l). Haematology and serum biochemistry identified a mild leucopenia (3.8×10^9/l; reference range 4.1×10^9 to 10×10^9/l) and increased activities of GGT (73 u/l) and glutamate dehydrogenase (128 u/l, reference range <12 u/l). All other hepatic markers, including bile acid concentrations, were within reference ranges. Over the following 18 months, laboratory parameters were assessed on 7 occasions and revealed that PPID was subsequently poorly controlled (ACTH 26.7–154 pg/ml), and the suspected *type 2* diabetes mellitus persisted (fasted insulin 34.7–121 mu/l, and glucose on 2 occasions measured 10.9 and 11.2 mmol/l). The pony also showed variable evidence of hepatic compromise (activities of: GGT 322–811 u/l; ALP 202–590 u/l; AST 202–590 u/l; glutamate dehydrogenase 117–199 u/l; and bile acid concentrations 8–20 μmol/l). Serum TG determined on 3 occasions were increased each time (7.96, 22.1 and 6.24 mmol/l). Clinically, the pony remained bright, appetent and relatively sound throughout this time, with the exception of a brief episode of diarrhoea following an increase in pergolide dose to 6.6 μg/kg bwt.

Case 7

A 28-year-old pony was presented for recent onset of weight loss over the last 3–4 weeks despite a normal appetite. It also had a history of hypertrichosis, not shedding its coat, polyuria and polydipsia and muscle wastage. On examination, the pony was in poor body condition (weight approximately 200 kg, BCS 1.5/5) but otherwise bright and apparently healthy. Laboratory evaluation identified gross lipaemia, increased concentrations of TG (16.3 mmol/l), ACTH (195 pg/ml, seasonally adjusted reference range <27 pg/ml) and increased activity of GGT (270 u/l) and AST (1547 u/l). Treatment with pergolide (5 μg/kg bwt) was initiated, and throughout the following month the pony's condition improved (BCS 2/5) and TG concentrations and GGT activity decreased (1 mmol/l and 156 u/l, respectively), although ACTH concentrations remained increased (177 pg/ml).

Discussion

Hypertriglyceridaemia secondary to systemic disease has been extensively described and is commonly associated with a negative energy balance [3]. Inappetence and lethargy are consistent clinical features in ponies and horses [1,2,13–15], and affected animals can be hypo-, normo- or hyperglycaemic [6,16]. In ponies, and less commonly in horses, hepatic lipidosis accompanying hypertriglyceridaemia can be a serious complication that is potentially fatal if the liver ruptures, leading to exsanguination into the peritoneal cavity [2,13,14]. Hypertriglyceridaemia in ill horses and ponies is therefore regarded as a condition that requires prompt treatment aimed both at correcting the underlying negative energy balance and decreasing TG concentrations. Treatment includes enteral or parenteral nutritional support as well as adjunctive therapy, such as insulin infusion to reduce activity of hormone-sensitive lipase or heparin administration to increase lipoprotein lipase activity, although the efficacy of the latter treatments remains controversial [17].

Horses and ponies described in this case series differ from previous reports of hypertriglyceridaemia in that all animals maintained a bright attitude and normal to increased feed intake. In addition to hypertriglyceridaemia, all had clinical and laboratory findings supporting one or more endocrine disorders, notably insulin resistance and PPID. Furthermore, these endocrine disorders were accompanied by *type 2* diabetes mellitus in all animals, except for one animal in which glucose concentration was not determined. Diabetes mellitus, defined as chronic

hyperglycaemia, may be caused by lack of insulin production (*type 1*) or by insulin resistance and ultimately pancreatic β cell failure (*type 2*). In horses, *type 2* diabetes mellitus occurs most commonly in association with PPID [18]. This might be due to the high frequency of insulin resistance in horses with PPID, having been identified in 60% of cases [19]. Insulin resistance is also viewed as a key metabolic disturbance in development of hyperlipaemia in ponies [14] and is the hallmark of equine metabolic syndrome (EMS). Altered lipid metabolism, including increased lipolysis and ketogenesis, have been described in equids with PPID and EMS [20–22]. Although they may be increased, reported TG concentrations in horses and ponies with EMS have typically been lower in comparison to the cases reported here, and gross lipaemia has not been described in animals with EMS or PPID [21,22]. As the increases in TG concentrations were far more dramatic in the cases reported here, the authors suggest that the pathophysiology differs from the mild dyslipaemia that has been reported in the literature in horses and ponies with EMS [21].

Weight loss and loss of muscle mass are recognised clinical signs of PPID, but the underlying pathophysiology is currently not well understood. Loss of epaxial and rump muscle mass has been attributed to protein catabolism secondary to increased cortisol activity [23], but pathophysiological explanations for true weight loss are lacking. Excessive glucocorticoid concentrations can lead to activation of adipose tissue lipases [24], and hormonal imbalances in conjunction with a negative energy balance have long been suspected to be contributory factors in equine hyperlipaemia [14]. Rapid weight loss had been noted in 3 animals in this report, suggesting a negative energy balance despite an increased caloric intake. It is possible that a predominance of catabolism- and lipolysis-favouring hormones, in conjunction with insulin resistance, may have triggered excessive lipolysis, weight loss and hypertriglyceridaemia. This assumption is supported by the improvement in body condition after initiation of therapy, which was paralleled by a decrease in TG concentrations in some of the animals reported here.

Considering the degree and chronicity of hypertriglyceridaemia observed, it is surprising that none of the animals appeared to be clinically affected by its presence. In 5 animals, hepatic enzyme activities were determined, and mild to marked increases were identified in all of them, suggesting subclinical hepatic disease and/or lipidosis. This was histologically confirmed in Cases 2 and 4. In 5 animals, biochemical abnormalities resolved or improved with initiation of appropriate treatment (pergolide and insulin, respectively). In Case 4, the owner did not follow recommended treatment and, interestingly, the animal did not appear to suffer any ill effect despite dramatically increased TG concentrations for more than 7 years. These findings could argue against the perception that hypertriglyceridaemia is a causative factor in the lethargy and anorexia observed in horses and ponies with gross lipaemia or severe hypertriglyceridaemia secondary to systemic disease [8]. However, in our report only TG concentrations were determined, and it is also possible that the lipid composition of the observed dyslipaemia could differ between the 2 disease syndromes and that one might cause more profound organ dysfunction and pathological changes than the other. Alternatively, it is possible that hypertriglyceridaemia secondary to endocrine disorders develops over a more prolonged period of time, which could allow for initiation of compensatory mechanisms in the liver and other organs.

Azotaemia has been suggested to contribute to the development of hypertriglyceridaemia in systemically ill horses [7], but it remains unknown whether azotaemia is a cause of hypertriglyceridaemia or an effect of systemic disease and/or hypertriglyceridaemia [1]. Creatinine and BUN concentrations were normal in all cases in which they were measured (Cases 1–5).

In summary, horses and ponies can develop severe hypertriglyceridaemia secondary to endocrine disorders that are associated with hyperglycaemia and insulin resistance. Although serum biochemical evidence of hepatic disease was present, no ill effects were noted clinically in the animals, and the clinical significance of the hypertriglyceridaemia remains unknown. Primary treatment of hypertriglyceridaemia does not seem to be indicated in these cases, and abnormalities might resolve with treatment of the underlying endocrine disorder, which coincides with resolution of the catabolic state and weight gain in some animals.

Authors' declaration of interests

No competing interests have been declared.

Ethical animal research

Not applicable. Retrospective study of clinical records.

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Authorship

Bettina Dunkel contributed the idea, contributed to data collection and wrote the manuscript. Sophie Wilford contributed to data collection. Nicholas Parkinson, Phoebe Smith, Christie Ward, Lisa Grahame, Tim Brazil and Harold Schott contributed cases and contributed to revision of the manuscript.

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