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Case Report

When Changing the Hay Makes a Difference: A Series of Case Reports

Damiano Cavallini[a,+], Livio Penazzi[b,+], Emanuela Valle[b,+,*], Federica Raspa[b], Domenico Bergero[b], Andrea Formigoni[a], Isa Fusaro[c]

[a] Department of Veterinary Science, University of Bologna, Ozzano Emilia (BO), Italy;
[b] Department of Veterinary Science, University of Turin, Grugliasco (TO), Italy
[c] Department of Veterinary Science, University of Teramo, Piano d'Accio (TE), Italy;

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ABSTRACT

Dry hay (composed of grass, legumes, or a mixture of the two) provides the primary source of alimentary fiber in stabled horses with limited access to fresh pasture. However, hay can also give rise to health problems in the horse, depending on the quality and quantity of its components. Pathologies may be rooted in biological problems, such as inadequate digestion disturbances, or reflect mechanical difficulties—for example, due to the presence of sharp plant parts that irritate the oral mucosa, or due to physical intake problems that inhibit consumption. Unwanted plants in the hay may cause stomatitis and affect the oral mucosa, resulting in inappetence, hemorrhagic drooling, gingival hyperemia, edema, and ulcerative lesions, as reported in case 1 of the present study. Horse dysphagia, defined as a difficult in ingesting feed through the mouth and esophagus, is another important cause of malnutrition in the horse, and identifying the site of its origin is important in order to provide practical advice for nutritional management, as reported in case 2. Free fecal water syndrome (FFWS) is a condition where the horse exhibits 2-phase feces expulsion, with an initial solid phase followed by a liquid phase. Although the etiology of FFWS is still unknown, hay quality seems to play a key role, as the outcome of case 3 suggests. This case series highlights the importance of hay quality and of providing an appropriate and adequate fiber intake. Moreover, good hay management becomes crucial when horses are affected by contextual pathologies, such as stomatitis, dysphagia, or FFWS.

1. Introduction

Hay is defined as cut, whole-plant (except roots and seeds) grass, legumes, or other herbaceous plants, air-dried or wilted in the field or barn, and presenting a preserved dry matter content ideally above 85%. Hay is the most common form of fiber provided to stabled horses with limited or no access to fresh pasture, which may be due to unfavorable environmental conditions, or the grass's unsuitability [1]. Horses are adapted to a slow and almost continual intake of a diet rich in structural fiber and low in rapidly hydrolyzable carbohydrates [2]. Hay can supply the fiber requirements for the production of volatile fatty acids by fibrolytic bacteria in the hindgut [3]. Compared with a diet based on concentrates, a hay-based diet increases the time horses spend exhibiting feeding behavior by increasing the time spent masticating and promoting saliva production. Moreover, hay improves the behavioral repertoire (i.e., the "time-budget") of the horse (time resting, standing, searching, etc.) [4,5,6].

Different kinds of hay are commonly given to horses: meadow hay is the most common and suitable type, but those based on alfalfa, clover or grass alone are also often used, depending on market availability. Hay should always be subjected to proper feedstuff analysis in order to ascertain its relative quality [7].

The most common nutritional risk factors for equines are related to a decrease in forage intake, an altered nutritional value of the forage, or its poor hygienic quality. In particular, the poor nutritional and hygienic quality of hay has been shown to be responsible for a number of health disorders, including gastric ulcers, colic, diarrhea, and recurrent airway obstruction [1]. However,

Abbreviations: FFWS, free fecal water syndrome; BCS, body condition score; BW, body weight; INRA, Institut National de la Recherche Agronomique; WSC, water soluble carbohydrates.

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* Corresponding authors at: Emanuela Valle, Department of Veterinary Science, University of Turin, Largo Paolo Braccini 2-5, 10095 Grugliasco (TO), Italy.
E-mail address: emanuela.valle@unito.it (E. Valle).
+ Authors equally contributed to this work.

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other horse pathologies may be related to hay consumption, which can result in problems of a physico-mechanical nature (related to the toughness of the stems or to the coarseness of the type of grass itself) or to biological problems (related to inadequate digestion, according to the quality and quantity of the hay fed).

Among the physico-mechanical causes of pathology, hay may contain a wide range of unwanted plants that have the potential to cause irritation and injuries to the horse's mouth [8]. Such plants may possess thorns, bristles, stinging hairs, or sharp awns, and may produce a variety of lesions, ranging from the reddening of the mucosa to deep granulating ulcers on the tongue and gingiva [9]. The oral lesions caused by inappropriate botanical species may result in excessive salivation or slobbering, the formation of vesicles and ulcerations, and lead to local infection, pain, difficulty in eating, and decreased feed intake in the horse [10]. Grass awns are often not visible in the ulcers, as they are covered by a layer of granulation tissue. Histological examination usually reveals pyogranulomatous lesions with the presence of foreign bodies, such as bristles, stuck into the mucosa [11].

The consumption of hay can also produce mechanical obstructions that result in dysphagia—defined as difficulty in feed intake through the mouth and esophagus into the stomach [12]. Although horses can be affected by different causes of dysphagia, the consumption of long-stem hay can be a key etiological factor as it can hinder the healing of structures associated with the deglutition process. The literature contains many case reports of dysphagia in equines [13]. However, these case reports do not give adequate information about the nutritional management of the horses affected by dysphagia, and are primarily focused on parenteral nutrition or enteral nutrition via a nasogastric tube. Instead, in such cases it is important to receive the appropriate nutritional support, especially in long-standing disease processes [14]. In particular, it is important to identify the site where the dysphagia originates—specifically, whether it is pre-pharyngeal, pharyngeal, or post-pharyngeal [12]—as this can affect voluntary feeding. Even if the causes of dysphagia and the subsequent medical therapies vary, the nutritional approach can be standardized in cases in which voluntary feeding is possible. A number of options are available, such as pelleted feeds made into a slurry consistency, custom-made diets, or commercial human and equine liquid diets, and each one should be tailored to the horse's condition [14].

Finally, it has been anecdotally reported that nutritional factors may be related in some cases to the onset of diarrhea, in which free fecal liquid or free fecal water syndrome (FFWS) in horses is one of the major unsolved issues [15,16]. In this syndrome, the horse usually produces one solid phase, commonly consisting of rounded scybala, and one liquid phase with free fecal liquid, which can daub the hind-quarters of the animal, causing discomfort and possibly skin lesions [17,18]. In the case of FFWS, its symptoms may prove to be difficult for the veterinarian and owner to treat if they are incorrectly diagnosed as mild chronic diarrhea, which would otherwise respond to a different intervention [19]. Different causes of FFWS have been suggested, including nutritional factors (e.g., diets rich in water soluble carbohydrates [WSC], overly cold drinking water, the feeding of wrapped forages) [17,18,20], management factors (e.g., stressful situations and/or hierarchy establishment) [18], or intrinsic factors (e.g., microbial hindgut dysbiosis) [18,21]. However, no study has been performed to date to ascertain to which extent each of these factors may be related to or contribute to the cause of FFWS, as the etiology of this disease is still unknown [19]. Nonetheless, nutrition—in particular hay intake—seems to play a role in the disease.

The aim of this series of case reports was to highlight the importance of hay management in stabled horses in light of the occurrence of specific pathologies: stomatitis, dysphagia, and FFWS.

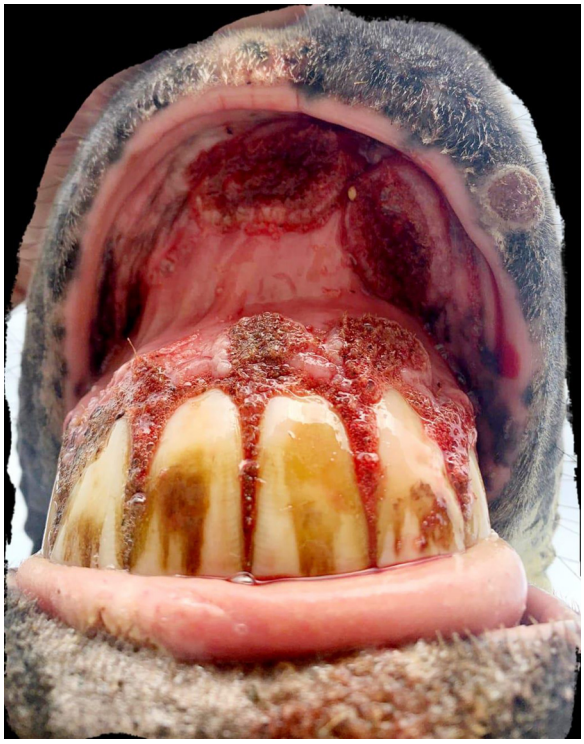

Fig. 1. Gingival hyperemia, edema, and ulcerative lesions recorded in clinical report 1.

2. Case presentations

2.1. Clinical report 1: Stomatitis in horses caused by the presence of weeds in the hay

The first clinical report involves 3 horses, a mare and 2 geldings, with a mean age of 10 ± 3 years, mean body weight (BW) of 475 ± 25 kg, and a body condition score (BCS) of 5/9. The horses were visited for reported inappetence, drooling, and excessive bloody salivation. All three horses were kept in box stalls with no access to pasture, and were in full work at the time of examination. The horses were fed a mixture of meadow hay and grain obtained from different sources and had free access to water. They were bedded on clean straw. The horses had started to refuse to eat the hay and exhibited excessive salivation, thus prompting the owners to request a full clinical examination. The horses' vital signs were normal and no abnormalities in the conjunctival mucosa were evident. However, horses exhibited anorexia, difficulty and pain when chewing, slightly enlarged mandibular lymph nodes, and drooling, at times with hemorrhagic salivation.

Examination of the oral cavity revealed brown, fuzzy material containing plant awns mixed with saliva adhered to the incisors at the gingival margin. The awns were embedded in the tissue perpendicular to the gingival surface.

Samples of the plant material from the gingiva were taken for further examination. Moreover, one sample of the meadow hay was collected to identify the botanical species present in the hay.

Examination of the oral cavity also revealed gingival hyperemia, edema, and varying degrees of ulcerative lesions, Fig. 1.

Ulcerative lesions mostly affected the buccal vestibule, the gingival collars of the upper incisors, and the upper lip margin. The lesions were rated as medium to large (1–4 cm long and 5 mm wide), and were circular in shape. They were highly painful, and located at the labial-gingival frenulum, the base of the lingual dor-

Table 1
Mechanical injurious plants [9].

Common Name	Scientific Name
Burdock bristles	Arctium spp.
Three awn grasses	Aristida spp.
Oat awns	Avena sativa
Sand burrs	Cenchrus spp.
Thistles	Cirsium spp.
Barnyard grass	Echinochloa crusgalli
Foxtail barley awns	Hordeum jubatum
Barley awns	Hordeum vulgare
Mouse barely	Hordeum murinum
Prickly pear cactus, cholla	Opuntia spp.
Rye awns	Secale cereale
Bristle grasses, foxtails	Setaria spp.
Yellow foxtail	Setaria glauca
Horse nettle	Solanum carolinensis
Buffalo burr	Solanum rostratum
Needle, spear, or porcupine grass	Stipa spp.
Wheat awns	Triticum aestivum
Puncture vine, goat head	Tribulus terrestris
Stinging nettle	Urtica spp.
Cockle burrs	Xanthium spp.
Buttercup	Ranunculus spp.

sum, on the soft palate, and the sides of the tongue. The affected tissues bled easily upon palpation.

Following clinical examination, a tissue biopsy was performed on each horse. Subsequently, tissue samples were analyzed for histology and, unexpectedly, eosinophilic infiltration was found.

According to the anamnesis, the symptoms described appeared a few weeks after the hay had been changed to one of lower quality (rich in weeds and lignificated portions). Immediate replacement of the hay with a new source of good quality hay rich in young-cut highly digestible plants was recommended. Once this was done, spontaneous lesion resolution occurred within a few days. Therefore, no antibiotic administration or antiseptic solution flushing was needed.

As the hay source was considered to be the likely cause of stomatitis, a specific investigation was conducted to evaluate which botanical species were involved in the pathogenesis. Macroscopic evaluation of the hay revealed the presence of Setaria glauca and Echinochloa crus-galli as the unwanted plant species most likely responsible for the lesions.

Oral ulcers and erosions are often attributed to physical trauma induced by coarse forage or plant awns [9]. Few reports of grass awn-associated stomatitis in horses are present in the literature: two outbreaks incriminated yellow bristle grass (Setaria lutescens); one case was shown to be caused by triticale hay [22,23], and one ulcerative stomatitis outbreak occurred due to Hordeum murinum seed heads [24]. Other reports are anecdotal only [11].

In this present case, we reported an outbreak of ulcerative stomatitis in three horses caused by Setaria glauca and Echinochloa crusgalli seed heads. In many cases of ulcerative or erosive stomatitis, an offending awn or other parts of the plant may not be detected. Examination of the forage being fed to the horses should be conducted in the case of erosive stomatitis to identify potential irritants [9,24]. Setaria glauca and Echinochloa crusgalli are common grasses in the southern regions of Europe, and if present in abundance in the hay they may cause traumatic forms of stomatitis, which should be differentially diagnosed from other forms of stomatitis. A list of the most common plants with the potential to cause mechanical injuries is provided in Table 1 [9]. It is essential that horse owners develop the ability to identify these botanical species to prevent mechanical injuries and hay-related stomatitis. The demonstration of the plant awns in the lesions and hay samples, together with the resolution of the lesions after removal of the hay from the horses' diet, confirmed the diagnosis.

Undesired plant species tend to be more resistant to drought compared with the more desirable grasses, thus the probability of their presence is higher in hay harvested in the summertime, especially in the Southern Europe where drought and irrigation restrictions are more common. As a consequence, the increasing scarcity of good-quality hay in the summer results in an increase in its price, thus favoring the use of cheaper and lower quality hay by many horse owners.

Hay for horse feed needs to meet the nutritional requirements of horses (determined predominantly by the hay's nutrient content and digestibility) and be of adequate hygienic quality (i.e., the absence of mold spores, biological and/or chemical contaminants) [1]. Hay destined as forage should also be inspected macroscopically. Horse nutritionists and breeders should know how to check the hay visually, and use touch and smell to assess its quality. Horses with painful mouths do not tolerate long fiber feeds, and their nutritional management should be based on a soaked mixture of commercial chopped hay feeds such as hay cubes, pelleted hay and hay chaff; sugar beet pulp can also be used [1].

2.2. Clinical report 2: Two cases of horse dysphagia in which feeding long-stem hay was impossible

Horse 1: a 17-year-old gelding with a BW of 470 kg and BCS of 4/9. This horse presented chronic recurrent dysphagia caused by esophageal diverticulitis and subsequent weight loss. Horse 2: a 20-year-old mare with a BW of 350 kg and BCS of 2.5/9. This horse presented dysphagia resulting from masseter myodegeneration caused by selenium deficiency (blood analysis showed a selenium concentration of 62 μg/L, whereas vitamin E levels were within normal ranges), and subsequent weight loss (no signs of rhabdomyolysis or generalized muscle atrophy were present). The dental status of both horses was normal. Both horses were unable to eat long-stem meadow hay, and the goals of the nutritional management was to promote fibrous feed intake via oral ingestion and to increase body weight. The key goals of the diet formulated were to: provide sufficient energy intake, offer different feed choices, provide the correct feed texture, provide a correct partitioning of meals (at least 3 per day), and permit a natural head position while eating.

Although hay should constitute the main component of the horse diet, equines can also tolerate long-term ingestion of finely grounded fiber (such as pelleted hay). Even though the parenteral route or the use of a nasogastric tube can be an option in these cases, it is desirable to support dietary intake by favoring spontaneous feeding behavior. In fact, voluntary feeding should be always preferred since nutrition via the gut contributes to the maintenance of intestinal health [25]. Moreover, parenteral nutrition should be limited, only being used when strictly necessary and for brief periods (maximum 4–5 days) [26,27], due to both financial and practical concerns. In human studies, parental nutrition is associated with catheter complications, sepsis, intestinal atrophy, and loss of gut mucosal barrier function [28]. Moreover, the use of an indwelling tube for feeding can lead to patient discomfort and pharyngeal and esophageal trauma (especially in the case of repeated intubation), and if left in place for more than 4 days it may even lead to esophageal perforation [29]. The enteral route is reported to be associated with fewer complications regarding fluid and electrolyte overload, and, most importantly it is better for gastrointestinal health as the fiber in the diet supplies the volatile fatty acids required for providing energy to colonocytes [30]. Moreover, feed palatability is a crucial for encouraging unwell horses to eat properly, and grass is usually the most palatable option [31], providing both a means to increase consumption time and a source of fiber.

Table 2
Nutritional composition of the diets fed before vs. after nutritional consultation.

Before Nutritional Consultation					
Horse	UFC*	CP** (%)	EE** (%)	CF** (%)	Ash** (%)
1	4.76	8.70	1.70	33.90	9.00
2	5.37	9.30	1.30	31.10	8.20
After Nutritional Consultation					
	UFC*	CP** (%)	EE** (%)	CF** (%)	Ash** (%)
1	4.98	9.20	1.30	34.20	9.10
2	6.11	11.00	1.70	35.30	9.40

* Calculated as reported in INRA [38].
** Analyzed as reported in previous papers [39,40,41,42].

In both clinical cases, the energy requirements were calculated according to their respective desired BWs (initial BW kg + [{target BCS – actual BCS} x18]) [32]. In 2016, Valle and colleagues reported that an additional 20 Mcal must be consumed per day in order to gain one BCS unit, considering a total daily energy intake that does not exceed 120%–125% of maintenance energy requirements [33]. In the present cases, the horses' energy requirements were met by gradually increasing the amount of pelleted hay and short-stem hay over the course of two weeks, as explained below.

Since the horses showed dysphagia, long-stem hay was removed from their diet. Indeed, the provision of long-stem hay would have led to a worsening of the clinical condition in both cases. In particular, esophageal diverticula are difficult to treat as they can lead to a vicious circle of recurrent esophageal obstruction. Feed that is not sufficiently masticated can remain stuck in the diverticula, causing damage to the mucosa and leading to the formation of scar tissue. Moreover, masseter myodegeneration hinders proper mastication, making horses reluctant to eat hard or effort-requiring feeds, such as long-stem hay. The roughage requirements (min 1.8% BW forage [1], according to our nutritional counseling service) were met using pelleted hay (80%) mixed with short-stem hay (<2 cm) soaked in warm water so as to form a slurry. The pelleted hay provided 25% of the energy requirements for the first 4 days, rising to 50% for the following 3 days, 75 % for the subsequent 4 days, and 100% thereafter 10 days after the start of the new diet. The short-stem hay was finally added at 2 weeks from the start of the new diet to evaluate if it was well tolerated by the horses, and continued thereafter. A balancer feed was provided to fulfill protein, fat (max 10% of the energy intake), vitamin, and mineral requirements (especially the selenium requirement, 1 mg/500 kg BW [34]). At least 4 meals/d were recommended, and to let the horse graze for at least 1 hour between meals for a total of at least 3 hours a day. We suggested providing the feed on the ground to facilitate the correct positioning of the head [35,36].

Horse 1 started to gain weight and no constipation problems were observed; after 8 months, long-stem hay was reintroduced, providing 15% of the daily feed ration. Horse 2: started to eat more easily but was euthanized at 1 month due to medical reasons not linked to the diet.

In summary, in cases in which eating hay presents a problem for a horse, roughage requirements should be fulfilled using alternative fiber sources.

2.3. Clinical report 3: Two cases in which a hay substitution approach was used to control free fecal water syndrome (FFWS)

Horse 1: an 18-year-old Italian Saddlebred gelding with a BW of 560 kg and BCS of 6/9. The horse was receiving treatment with Pergolide for pituitary pars intermedia dysfunction (equine Cushing's disease), and the owner complained about chronic intermittent loose feces and fecal liquid around the anus. Horse 2: a 10-year-old Hannover gelding with a BW of 582 kg and BCS of 5/9. The horse was presented for examination due to chronic (3 years) mixed formed and watery feces, especially after competition or training.

Both horses had been prescribed previous treatments by the referring veterinarian to reduce the episodes of free fecal water, with only mild improvements in symptoms achieved: horse 1 had been treated with two different probiotic supplements, completing a 20-day course of one followed directly afterwards by 20 days of the second; horse 2 had been treated with prednisolone (1 mg/kg orally) with a gradually decreasing dosage protocol over 15 days and probiotic supplement for the same duration. Neither of the horses showed any biochemical or blood alterations, and clinical parameters were within normal ranges.

The diet of horse 1 was composed of around 10 kg of first cut meadow hay plus 1.4 kg of low-starch (<10%) concentrate (muesli). The diet of horse 2 was composed of around 10 kg of first cut meadow hay and 1.5 kg of high-starch (>50%) concentrate (Tables 2 and 3). The hygienic status of the hay was evaluated visually according to the scoring system suggested by Kamphues et al. [37].

The diets of both horses were rebalanced in order to meet the nutritional requirements for sport horses as set out by the Institut National de la Recherche Agronomique [38]. Moreover, half of the forage (first cut long-stem meadow grass hay) was replaced with finely ground or pelleted meadow hay, while the other half was replaced with first cut meadow hay from a different supplier. The owners were prompted to gradually increase their horse's grazing time at pasture to up to 4 hours/d. Finally, the concentrates were eliminated in favor of complementary fibrous mixes with low WSC, and the number of rations was increased from 3 to 4 meals/d. Probiotic supplementation was continued for a further 20 days in both horses.

Both horses showed a gradual and constant improvement in feces quality over the next month, and fecal water was no longer present in the perianal area of either horse. Both animals continued to present occasional episodes of free fecal water during particularly intense training sessions or after competitions, but besides that their overall condition and behavior improved (no more tail swishing or trampling/stamping of the hind legs).

Changes in forage batches and forage types (i.e., meadow hay or grasses vs single plant species cuts or legumes) has previously been shown to have a beneficial effect on reducing symptoms of FFWS in horses [17,19]. This could be due to several different aspects of the forages, such as plant maturity, harvest time, or botanical species composition [43], which can in turn affect fiber content and the overall digestibility of nutrients [1]. Consequently, this may affect the water holding capacity of the digesta due to the heterogenous hydrophilic properties of different fibers [44]. Indeed, the intake level of neutral detergent fiber can have a direct effect

Table 3
Diet composition after nutritional consultation.

Horse	Feedstuff Used			
1	First cut meadow hay: 2% BW (as fed) from another supplier	Pelleted meadow hay 2.4 kg	Low starch concentrate (pellet) 0.8 kg	Vitamin/mineral balancer 0.075 kg
2	First cut meadow hay: 2% BW (as fed) from another supplier	Pelleted meadow hay 3.2 kg	Complementary fibrous mix 1.6 kg	Complementary pelleted vitamin/mineral balancer 0.6 kg

on fecal composition as fiber-rich feedstuff provides for a steadier production and absorption of nutrients and water compared with low-fiber feeds. In particular, different kinds of roughage can directly influence the intestinal environment, and thus the fibrolytic bacteria which ferment fiber into short-chain fatty acids [45]. Indeed, feeding different kinds of forages leads to different patterns of microbial populations in the hindgut [46], and re-modulating the diet may change these clusters of bacteria, positively affecting the predisposition of individual horses with FFWS to digest the fiber, and improving their fecal characteristics [16,47].

3. Conclusions

This case series highlights the importance of appropriate horse nutrition and management. Hay quality and quantity is well known to have a significant impact on equine health and well-being; nevertheless, and the provision of inadequate roughage to horses is not uncommon. Fibrous feed sources equating to at least 1.5%–2.0% BW should be offered in dry feed, divided into 3 or more meals/per day. Moreover, hay quality varies both between and within years according to seasonal trends, from both the nutritional perspective and with regard to the constituent plant species. Our case series highlights three specific horse pathologies in which long-stem hay was either not recommended or where an inadequate hay quality was the probable cause or exacerbated an underlying disease, causing the pathology to become chronic and difficult to treat. In such situations, the consultation of a horse nutritionist is needed in order to resolve the problem and avoid the repetition of nutrition-associated clinical cases. In particular, it is crucial to recognize when hay should be substituted with one of better-quality or with alternative fiber sources, such as hay cubes, pelleted hay, hay chaff, or even sugar beet pulp.

Authors' contributions

EV and DB designed and supervised the study. DC, LP, EV, and FR conducted the clinical examination. DC and LP wrote the first draft of the manuscript. EV, FR, DB, AF, and IF revised the manuscript. All authors have read and approved the final manuscript.

Availability of data and materials

Not applicable.

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