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Review article

Risk factors associated with colic in horses

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Abstract – Many factors have been identified as risk factors for colic in horses in several epidemiological studies. The aim of our paper was to review the results of 12 epidemiological studies, in order to assess the impact of each risk factor for colic. According to the literature, the factors that increase the risk of colic are feeding practices (type and quality of food, type and changes of feeding), the intrinsic factors of horses (sex, age and breed), management (type and changes of housing and activity), medical history (a previous colic, administration of a medical treatment) and parasite control (the presence of worms and type of deworming program). Several individual factors were incriminated as risk factors by all the studies. Nevertheless, the different studies did not always agree on the role of other risk factors. The conclusions were tightly related to several criteria in the selection of the study population, like the type of the epidemiological study, the number and the origin of horses included and the location of the study.

colic / epidemiological studies / horse / risk factors / feeding practices

Résumé – **Facteurs de risque associés au syndrome colique chez le cheval.** Différentes études épidémiologiques ont mis en évidence plusieurs facteurs de risque de coliques chez le cheval. L'objectif de cet article a été de faire une synthèse des résultats de 12 études épidémiologiques, dans le but de déterminer l'impact de chaque facteur de risque dans l'apparition des coliques. D'après la littérature, les facteurs augmentant les risques de coliques sont les pratiques d'alimentation (type et qualité des aliments, changements dans l'alimentation), les caractéristiques physiques des chevaux (âge, sexe, race), les pratiques d'élevage (type et changement de logement et d'activité), le passé sanitaire (historique des coliques, traitements médicaux) et le contrôle du parasitisme (présence de parasites,

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type de programme de vermifugation). Plusieurs facteurs de risque ont été identifiés par les 12 études épidémiologiques. Néanmoins, les différentes études ne sont pas toujours d'accord sur le rôle joué par certains de ces facteurs. Les conclusions de chaque étude semblent en effet étroitement liées à certains critères dans la sélection de la population étudiée, comme le type d'étude réalisée, le nombre et l'origine des animaux inclus dans l'étude, le lieu de l'étude.

coliques / étude épidémiologique / cheval / facteur de risque / pratiques d'alimentation

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1. INTRODUCTION

Digestive diseases, such as colic, diarrhoea, or enterotoxemia, represent 50% of the medical problems resulting in the death of adult horses [1]. Colic, defined as abdominal pain of digestive origin, is the major part of them: according to the National Animal Health Monitoring System (NAHMS) in the USA, the incidence of colic is estimated at 13.6% per year in a representative sample of operations of horses 6 months old or older in 28 states of the USA [35]. Although 75% of the colic cases were solved in less than 24 hours, 67% of the horses with colic were examined by a veterinarian, of which 85% received a treatment [30]. The mortality rate for the horses referred to veterinary clinics can be high [25, 34, 35].

Every horseman has his own opinion of the cause of colic. Few scientific papers, however, have examined the aetiology of colic and the ways to prevent it [4]. Epidemiological studies allow us to test the hypothesis of a relationship between exposure to a risk factor and the development of a disease.

The aim of the present review was to synthesise the information about different factors that have been associated with equine colic in published epidemiological studies. This paper first presents the 12 epidemiological studies included and their epidemiological methods; the risk factors found in this literature are listed in the second part; a third part comments on the validity and reproducibility of the results obtained in these studies.

2. STUDIES SELECTED AND METHODS USED

We identified 12 epidemiological studies concerning colic. Their main characteristics are shown in Table I. Three types of epidemiological studies were mainly used; they can be classified from those that are better at revealing risk factors to those that are less efficient: cohort studies, case-control study designs and cross-sectional studies [2, 17, 31]:

(1) Cohort studies compare the incidence of one disease in an exposed population and in a non-exposed population taken as a control; subjects are included in the study after their exposure has been determined and are followed forward in time to see if the disease appears. This type of study allows an accurate measurement of risk but generally requires a long period of time and must include a large number of subjects.

The Cohort studies were the following: Kaneene et al. [16] observed 138 farms in Michigan for 2 years and collected data monthly on 3 925 horses. Tinker et al. [29, 30] observed, for 1 year, colic events among 1 427 horses from 31 farms in Virginia and Maryland.

(2) Case-control studies compare the frequency of a previous exposure between subjects that develop a disease (cases) and subjects that do not develop the disease of interest (controls). The subjects are included in the study at the time of disease appearance; then the exposure is measured. This type of a study is less expensive than cohort studies since it is conducted over a short period of time, with a limited number of cases and controls. The difficulty of this type of a study is to well-determine the characteristics of the controls, which must be comparable to the cases.

The case-control studies were the following: the first case-control study of colic used a teaching population at a hospital in Minnesota that was examined over a period of 10 years [25]. The study included 320 cases of colic and 3 610 controls and measured the association of colic with intrinsic factors and medical management. To describe the different types of colic diagnosed

Table I. Characteristics of the 12 etiologic studies.

Reference number	Type of study	Period (Dates)	Number of horses	Number of Cases	Number of Controls	Horses treated in clinic	Origin of data	Data collect	Country
[5]	C.C.[a]	15 months (10/91–12/92)	1 214	768	446	No	Veterinarians practice	Registration of clinic and control horses	USA
[6]	C.C.	15 months (10/91–12/92)	1 642	821	821	Yes	Veterinarians practice	Registration of clinic and control horses	USA
[7]	C.C.	12 months (03/97–02/98)	2 060	1 030	1 030	No	Veterinarians practice	Clinic files	USA
[16]	C.[a]	2 years (02/92–01/93) (05/93–04/94)	3 925 (138 farms)	77	/	No	Farms practices	Registration of health events	USA
[20]	C.C.	2 years (01/89–12/90)	300	200	100	No	Veterinarians practice	Registration of clinic and control horses	England
[21]	C.S.[a]	?	231	116	115	No	Hospital practice	Feces analysis	England
[22]	C.S.	18 months	206 60	103 sp. c.[a] 20 il. i.[a]	103 40	No	Veterinarians practice	Serums and feces analysis	England
[25]	C.C.	10 years (07/74–06/84)	3 930	320	3 610	Yes	Hospital practice	Clinic files	USA
[26]	C.C.	11 months (03/91–01/92)	812	406	406	Yes	Hospitals practice	Interview by phone	USA
[29]	C.	1 year (11/90–11/91)	1 427 (31 farms)	151	/	No	Farms practices	Events reported on a calendar	USA
[30]	C.	1 year (11/90–11/91)	948 (31 farms)	86	/	No	Farms practices	Events reported on a calendar	USA
[34]	C.S.	5 years (1979–1984)		4 644	/	Yes	Hospitals practice	Clinic files	USA – England

[a] C.: Cohort study; C.C.: Case/Control study; C.S.: Cross Sectional study; sp. c.: spasmodic colics; il. i.: ileal impactions.

in England and associated risk factors, 200 cases were compared to 100 controls from the practice of 7 English veterinarians [20]. Cohen et al. [6] worked with 82 Texas veterinarians, who collected data on one case of colic and one associated control monthly for 15 months. This report described 821 cases and 821 controls. A second paper concerned only the cases of chronic or intermittent colic [7]. The same year, 5 clinics from the north-eastern USA and Canada after a pilot study of 7 months, conducted a study lasting 11 months that collected data from 406 cases of colic and 406 controls [26]. Another case-control study conducted with 145 Texas veterinarians collected data from 2 060 horses (1 030 horses with colic and 1 030 non-colic emergencies) to measure the association between dietary and management factors and colic [7].

(3) Cross-sectional studies compare the frequency of an exposure between the cases and controls. This type of study simultaneously measures, at or over a defined moment of time, both disease and other variables of interest, in order to examine their relationships. It allows to have a temporal sequence of causes but the effect is not examined so it is not well-adapted for etiological investigations.

The Cross-sectional studies included the following: a first study aimed at the inventory of the different types of colic, their diagnosis and the associated mortality rate in 4 644 clinical cases from 14 American and 2 English universities [34]. Proudman conducted a coprologic analysis of 116 cases and 115 controls from an English university to assess the association of tapeworms (*Anoplocaphala perfoliata*) with colic [21]. A subsequent study examined the association of tapeworms with either spasmodic colic or ileal impactions [22]: 103 cases of spasmodic colic were compared to 103 controls; 20 cases of ileal impactions were compared to 40 controls.

3. IDENTIFIED RISK FACTORS

Various risk factors associated with colic were identified (Tab. II). These factors were classified into six categories: feeding; parasitic infection; horse physical characteristics; management; health history; climatic conditions.

3.1. Feeding

3.1.1. Type, composition and amount of food

Horses are fed two main types of food: forages and concentrates. Both have been incriminated as risk factors for colic, although no relationship between colic and the type of feed was observed in Texas [6].

* Forages: a high percentage of fibre has been suggested to favour the impaction of the small intestine by stimulating intestinal motility, resulting in an important absorption of water [13]. In a study conducted on 18 horses involved in sporting events in Georgia and fed with a forage composed of *Cynodon* spp., a *graminae* very rich in crude cellulose, 7 horses developed impaction [23]. The author assumed that a high percentage of fibre in the diet increases the probability for impaction. Hay of poorer quality and low digestibility has been shown to predispose horses to colic [7]. However, other studies have shown opposite results: a decrease in colic was observed when horses only received forages [28, 30] or grass [7].

* Concentrates: while two studies conducted in Texas did not show any relation between concentrate ingestion and colic [7], the risk of colic increased with the quantity of concentrate ingested [28]; feeding more than 2.5 kg of concentrate per day appeared to increase the risk of colic by 4.8; more than 5 kg increased it by 6.3 [30].

Whole grain (except corn) was reported to reduce the risks of colic to 12% per ingested kilogram [30]. Although barley and

Table II. Risk factors cited in the 12 epidemiological studies.

Risk factor		Reference number[a]											
		[5]	[6]	[7]	[16]	[20]	[21]	[22]	[25]	[26]	[29]	[30]	[34]
Feeding practices													
Nature	Forage			X									
	Concentrate										X	X	
	Whole corn									X	X	X	
Changes	Changes of food	X	X	X		X				X	X	X	
	No regular watering			X	X					X			
Parasitism													
Type	Taenias						X	X					
Deworming	Deworming treatments			X	X					X			
	No deworming program			X									X
Intrinsic factors													
Sex	Stallions				X								
	Geldings	X											
Age	Age from 2 to 8 years										X	X	
	Age more than 11 years			X									X
Breed	Arabians	X		X					X	X	X	X	X
	Thoroughbred horses										X	X	
Medical history													
	Horses with previous colic	X	X	X						X	X	X	
	Medical treatment		X		X	X							
Management													
Housing	Indoor stalling			X									
	Changes in housing	X	X	X		X				X	X	X	
Activity	Exercise			X									
	Intense activity			X							X	X	
	Stressing activity				X								
	Changes in activity		X	X							X	X	
Weather-related factors													
	December, March and August										X		
	Weather change			X									

[a] [5] Cohen and Peloso, 1996. [6] Cohen et al., 1995. [7] Cohen et al., 1999. [16] Kaneene et al., 1997. [20] Proudman, 1991. [21] Proudman and Edwards, 1993. [22] Proudman et al., 1998. [25] Reeves et al., 1989. [26] Reeves et al., 1996. [29] Tinker et al., 1997a. [30] Tinker et al., 1997b. [34] White and Lessard, 1986.

oats were not associated with colic, the increase of the intake of concentrated food containing whole grain corn enhanced the risk by 3.4% per ingested kilogram in a case-control study, focused on 812 horses [26]. The arrival of concentrate in the colon causes a decrease in the luminal pH and modifies the intestinal flora, favouring the production of endotoxins; these imbalances could explain the observed association of the amount of concentrate with colic [3, 15].

Processed feeds, like pellets or sweetfeeds, have also been incriminated as risk factors [30].

3.1.2. Distribution of food

The mode and frequency of meals also have an impact on the apparition of colic: in

pastures, horses spend 75% of the day and 50% of the night eating, whereas in boxes, they are fed with a limited number of meals per day [3].

3.1.3. Changes of feeding

A change in the quality or the quantity of food, as well as a change in the time of feeding or in the schedule of feeding result in an increased risk of colic [6, 7, 20, 26]. In a population of 1 642 horses (821 cases and 821 controls), the risk of colic was multiplied by 2 during the 2-week period that followed any change in feeding [6]; this risk was 5 times greater in another case-control study conducted on 2 060 horses [7]. A study, conducted on 948 accumulated horse-years, showed that one change in feeding during the year multiplies the risk factor for colic by 3.6. More than one change during the year only multiplies the risk factor by 2.2 [30].

Among all the changes studied in feeding, that of the type of hay remains as the most significant factor [7]; the risk of colic was multiplied by 9.8 when the hay batch changed in a study of 1 030 cases of colic and 1 030 controls [7].

3.1.4. Watering

If not regular, watering increases the risk of colic; a reduction in watering is caused by several factors: the absence of a bucket in the stall [7], a limited access to water, in paddocks or on dry lands [26], a too low water temperature or a lack of water in cold weather [16, 33].

3.2. Internal parasitism

Intestinal parasites, and especially tapeworms and strongyles (*Strongylus vulgaris*) are triggering factors for colic due to their multiple actions: obstructive, traumatic, irritating, toxic actions. As a result, pain appears in the digestive system, transit is modified and motility is altered [19].

The results of the epidemiological studies regarding the role of parasites on the apparition of colic are controversial. On 3 925 horses, only 1.3% of the cases were reportedly associated with parasitism for 2 years (1 of 77 cases) [16].

3.2.1. Type of worms

Strongyles (*Strongylus* spp.) have been described as the cause for colic in horses [9]. These parasites could cause non strangulating colic, spasmodic in most of the cases [33]. The larvae were especially incriminated since they alter the motility of the small intestine and they migrate in the blood vessels resulting in thrombolic disorders [18, 23].

Although effective anthelmintics have been used and in spite of the reduction of the prevalence of strongyles in equids, colic cases due to parasites still occur [19]. The resistance of certain strongyle species (mainly *Cyathostomum*) to the anthelmintics used, and the outbreak of "new" parasites like tapeworms (*Anoplocephala perfoliata*), which occupy the ecosystem, might explain the continuing problem [19]. However, French et al. showed that deworming against strongyles does not increase the prevalence of tapeworms [11].

Before the 1980s, very few reports of tapeworm implication in equine intestinal pathology were observed; since then, many clinical observations and epidemiological studies have shown that this parasite should not be neglected [14, 21, 22]. When the confounding factors (age, breed and sex of animals) are taken into account, the presence of tapeworms increases the risk of ileal impaction by a factor of 3.4. Tapeworms are mass-located around the ileocaecal valve, which can disturb the transit from the ileum to the caecum [22].

3.2.2. Deworming treatments

In 821 horses treated by veterinarians for colic and 821 control horses, no association between colic and the frequency of deworming or the number of anthelmintics used was detected [6]. These results should be considered carefully since most of the horses in this study were consistently followed-up (daily anthelmintic treatment for 30% of the horses, monthly for 26% and every 2 months for 21%). In an ensuing study in Texas, the risk for colic was 2.2 times higher for horses which did not receive any regular deworming treatment [7]. Uhlinger, studying 3 groups of horses dewormed with different protocols, concluded that implementing a deworming program designed to have less than 200 eggs of strongyles per gram of feces, reduces the risk of colic [32]. A comparison between horses with colic and the control population established that an increase in the number of worming products enhances the risk for colic [16]. This result could be due to a biased selection: horses receiving better medical attention would be more easily treated for colic problems [16]. In another study, the risk for colic was multiplied by 2.1 in the 7 days following a deworming treatment [7].

3.3. Intrinsic factors

3.3.1. Sex

Generally, no significant difference was found in the distribution of colic according to sex [6, 7, 20, 25, 30, 34]. However, these results are still controversial: in a study conducted on 3 848 horses, the geldings appeared to be less affected than the stallions [16] whereas, during the same year, the opposite result was shown in a study conducted on 1 214 horses: geldings were more likely to colic [5].

3.3.2. Age

In a prospective study on 948 horses from 31 farms, an increase in the incidence of colic was observed between 2 and 8 years of age [30]. In another study, the risk for colic was multiplied by 1.5 for horses older than 10 years, compared to horses of 1 to 5 years of age [7]. Certain types of colic are more frequent in certain categories of age [6, 20, 25]: colic resulting from the obstruction of the intestine by enteroliths is frequent for horses over 11 years of age [12]. Large colon impaction and displacement seem to be more frequent in horses aged from 7 to 8 years whereas torsion and strangulation of the small intestine, large colon and small colon obstruction decreases with age [4, 33, 34]. Moreover, colic treatments requiring surgery are more frequent for older horses than for younger ones [4, 34]. But the relation between the age of horses and the apparition of colic is complex. Age can be an indicator of the horses' use, level of activity and feeding, which is related to the apparition of colic [30].

3.3.3. Breed

Arabian horses seem to be particularly at risk for developing colic [30, 34]: being an Arabian multiplies the risk for colic by about 2 [6, 7]. The authors propose that management characteristics are responsible for this prevalence of colic. Enterolithiasis is more frequent in Arabians or in miniature breeds [8]. In another study, Thoroughbred horses were found to be the only breed at higher risk for colic [30].

3.3.4. Other intrinsic factors

The size of the horse might also be an influencing factor. In a study describing the affected organs for the different types of colic, large warm-blooded breeds appear to be more likely to be affected by dorsal displacement of the large colon: the intrinsic factors of Hanovreian horses predispose them to a nephrosplenic entrapment [33]. The impaction of the small colon appears to be more frequent for ponies [4].

Finally, the temperament, and especially the irritability and excitability of the horse appear to be risk factors in a case-control study conducted on 800 equids [26].

3.4. Medical history

A horse is more likely to develop colic if it previously suffered from colic [6, 7, 26, 33]. This risk is even greater if the horse has an abdominal surgery history: studies conducted on cases and controls showed that a horse with a surgical history has a risk about five times greater than a horse with no surgical history [6, 7]. However, the mortality rate is not significantly different between horses suffering from colic for the first time and horses with a recurrent colic history (respectively 12% and 17%) [5].

Medical treatment or vaccination increases the risk for colic due to stress, especially if they have an effect on intestinal motility [16, 20]. On the contrary, no significant association was shown between recent vaccination and colic [6].

In several studies, no relation was found between dental disorders or the lack of dental care and colic, but many of these horses received regular dental care [6, 7, 30].

3.5. Management

3.5.1. Housing

Housing conditions seem to influence the risk for colic: horses maintained on pastures all year long are less exposed to colic than horses living indoors [7]. Moreover, a relative risk factor of 1.6 was measured for horses stalled more than 50% of the time [7]. It has been proposed that confinement, which generates stress and boredom, could increase the risk for chronic colic [3].

Changes in housing management particularly predispose horses to colic [6, 7, 24, 30]. A change in housing is often associated with a change in diet [7] and a change in activity [6, 7].

No association was found between colic and the type of bedding [6, 30]. However, the problem of straw as bedding is well-known by horsemen: impaction colic often appears just after a change of bedding, particularly if there is no other source of fibre.

3.5.2. Activity

No relation has been shown between the activity of the horse and the occurrence of colic [24]; although an intense activity (training, competition) could increase the risk of colic [7, 23, 29]. Activities associated with stress have the same effects [16].

Moreover, an increased risk is associated with any change in activity [6, 7]; in a study comparing 1 030 cases to 1 030 controls, the risk for colic was 2.2 higher for horses which had a change in activity during the 2-week period prior to examination [7]. This result could also be explained by the correlated change in diet [30] or in stabling [7].

3.6. Weather-related factors

The association of colic with weather-related factors has been considered by some investigators. A significant correlation was not found in measuring temperature variations and barometric variations in the 24 h preceding the colic crisis [10]. No association was found between rainfall or temperature and the incidence of colic [20].

Nevertheless, a study recorded more colic cases during hot months [27]; another one noticed more cases during December, March and August [29]. A weather change during the 3-day period prior to examination multiplied the risk of colic by 3.2 [7]. This result must be taken cautiously because, as addressed by the author, the owners of colic horses might have been more

likely to remember weather conditions before the crisis than those of control horses.

4. COMMENTS ON EPIDEMIOLOGICAL METHODS AND RISK FACTORS

4.1. Epidemiological methods used

Establishing the association of factors related to colic in horses is not easy. Reported epidemiological studies point out many factors that are responsible for colic, but do not always agree on their respective role, bringing some confusion. However their conclusions are tightly related to several criteria in the selection of the study population.

4.1.1. Number of horses included

In the 3 cohort studies, a great number of horses were observed for a long period of time (between one to five years). But the number of horses with colic was not very high: 105 cases on average. On the contrary, a great number of cases were studied in case/control studies: in the 6 case/control studies in this review, the average number of cases was 590 horses and that of controls 1 068. Concerning the three cross sectional studies [21, 22, 34], the number of horses with colic observed was respectively 116, 123 and 4 644 cases.

4.1.2. Definition of colic

In the 12 epidemiological studies, the definition of colic varied: whereas Proudman and Edwards [21] bring together all the intestinal diseases to design colic, the majority of the authors characterise this syndrome with the notion of pain associated to abdominal diseases [5–7, 29, 30]. Reeves et al. [25] specify it as "abdominal pain of digestive origin" and Kaneene et al. [16] relate it to distension of the stomach or intestines. Other authors do not give a precise general definition of colic but list either inclusion or exclusion parameters. Proudman in 1991 [20] made his analysis on six types of colic: spasmodic, flatulent, pelvic flexure impaction, other impactions, surgical and colitis. In 1998, he included only two types: spasmodic colic and ileal impaction colic [22]; White and Lessard [34] worked on obstructions, strangulation obstructions, peritonitis, non-strangulating infarctions and enteritis. Reeves et al. [26] excluded some diseases from their study (enteritis or colitis, peritonitis, primary ileus of unknown origin, broad ligament hematoma, undetermined surgical colic, recurrent colic, uterine torsion and colic secondary to another primary problem). This lack of accuracy in the definition of colic probably led to a variability among the case selection between these 12 studies. This should be a potential source of bias in the interpretation of the results; it can explain some of the differences observed in the implication of the risk factors. Some risk factors are actually only related to certain types of colic.

4.1.3. Origin of the horses

More than 30% of the epidemiological studies were only based on clinical records of the horses treated in veterinary clinics. This fact can introduce a bias in the selection of cases and controls: only the most serious (and the less frequent) colic were studied, especially when the study was conducted in a referral hospital; this does not allow to extend the results to every type of colic. Moreover, in these studies, horses that were chosen as controls were often sick animals, so they did not accurately represent the healthy equine population. The three cohort studies [16, 29, 30] were run on the equine population of several farms. In this type of study a great number of healthy horses was selected and every type of colic was analysed, on the contrary to what was studied with horses coming from veterinarian clinics.

4.1.4. Origin of data and data collection

9 studies were based on veterinarian and hospital practices [5, 6, 7, 20–22, 25, 26, 34]; using this kind of data allowed a pertinent collection of information concerning the medical characteristics of the cases; but information concerning the horse's environment (feeding practices, activity, housing…) was generally poorer, especially when studies were based on clinic files. On the contrary, three studies were based on farm practices [16, 29, 30]. Every event was reported on a calendar every-day, which provided much data and assured their accuracy before their subsequent analysis as potential risk factors.

4.1.5. Location of the studies

Half of the epidemiological studies were run in different regions of the United States, and a third in England. The results were difficult to extrapolate to other regions or countries, because management practices differed from one to another. Some studies grouped horses issued from American and English universities, which can introduce bias in the results because these animals were bred and managed in different conditions.

4.2. Risk factors of colic

Table II lists the factors cited in the literature as potential risk factors for colic and enumerates for each one the number of articles which identified it as a risk factor. This emphasises that all of these factors do not have the same importance for predisposing to colic.

Parasitism is the factor least cited in our bibliography. Intrinsic factors of horses (sex, age and breed) are often cited as potential risk factors of colic because these factors are easily and routinely assessed. Concerning medical history, being a horse with previous colic appears to be an important risk factor as well as being a horse which received a medical treatment; in fact, these treatments often have some effects on the intestinal motility and microflora, which might easily induce disorders of digestion. Abrupt changes in activity, in housing or in feeding practices were often cited in the bibliography. But these factors were strongly correlated to each other so it is difficult to know exactly which factor can induce a risk of colic.

5. CONCLUSION

Many different factors have been associated with the risk of colic in horses. Some of them, like the intrinsic or weather-related ones, cannot be altered by human will. However a better knowledge of their role should enable one to pay more attention. Most risk factors (feeding practices, parasitism, management) depend on practices, and should be under human control when they are pointed out. More studies are needed to precise the role of these practices. For instance, the analysis of 12 epidemiologic studies showed that feeding practices appear to be the most important risk factor for colic. Dietary practices were cited as risk factors in a fourth of the studies, however the association of nutrition and dietary factors with colic was specifically examined in only one study [7]. Even if everybody agrees that abrupt changes of food provokes colic, other characteristics of feeding practices, like the quality of food (and especially forage), the type and the rhythm of distribution, the intake, etc., require more investigations to better understand their impact on this disease.

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