

Observations on heaves.

An asthma-like syndrome in the horse

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Heaves is a respiratory disease of horses characterized by labored breathing. The disease may occur as discrete attacks lasting hours or days, or it may persist for weeks or months. Cough is commonly but not invariably present. Inspiration is accompanied by dilatation of the nostrils. Expiration occurs in two phases: first a passive phase followed by an active, more prolonged, and forceful phase involving contraction of the abdominal muscles which lift the abdomen and flanks—hence the designation “heaves.” Wheezing is usually heard on auscultation over the thorax and often also over the trachea. Evidence of infection is lacking. Horses developing this disease are usually regarded as worthless.

Although the reported findings at autopsy on horses with heaves resemble those of emphysema in man,¹ emphysema of significant degree was not found upon autopsy on any of seven horses with heaves.² This fact and the rapidly changing intensity of heaves in the animals currently under observation indicate that the disease may be a reversible rather than a fixed form of obstructive pulmonary disease. However, it is also probable that the syndrome called heaves actually embraces more than one disease entity.

MATERIALS AND METHODS

Horses with heaves were obtained as gifts or by purchase. Animals were regarded as having heaves if the owners stated that heaves had occurred and if a veterinarian had confirmed the presence of heaves. In every instance the

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animal's value had markedly decreased because of heaves, an important factor in making the animal available for study.

Table I gives a description of the animals. Animal No. 4 had, in addition to heaves, marked wasting of the hind quarters attributed to spavin and was semicrippled thereby. Three of the animals (Nos. 4, 5, and 7) were received in poor condition; labored breathing readily recognizable as heaves was present, and there was evidence of marked weight loss in one (No. 5). Animal No. 3 was free of manifestations of heaves when acquired and subsequently failed to exhibit heaves. Animal No. 6 was well nourished at the time of acquisition and did not exhibit evidence of heaves at that time. Before it was acquired, Animal No. 5 had been treated with irregular success with a diet lacking hay while being stabled in an old barn in which cows were also kept. It is of interest that an attack of heaves had developed within hours after a load of freshly cut hay was delivered to the barn and left close to but not within reach of the animal.

On arrival, the animals were either gradually changed over to a hay-free diet consisting of a mixture of grains* and beet pulp to replace hay, or they were put out to pasture. During the period of observation extending from January, 1962, to March, 1963, the animals were fed either the hay-free diet as described, or they were given hay (10 to 20 pounds per day) along with the grain mixture. Notes were kept regarding the presence or absence of cough, labored breathing, and wheezing, audible with or without a stethoscope. If an overt attack of heaves occurred at a time when hay was being fed, beet pulp was then substituted for hay. After subsidence of the attack and the passage of days, weeks, or months, hay was again fed. In one animal (No. 6), an attack subsided spontaneously, even though hay was continued in the diet.

Blood samples were obtained from the external jugular vein with a 6 c.c. disposable syringe and a No. 20, 2½ in. hypodermic needle and were thoroughly mixed with EDTA as an anticoagulant.† Sedimentation rates were performed by the Wintrobe-Lansberg³ method. Readings made at 5 minute intervals on a number of samples of normal equine blood indicated that sedimentation was very rapid. We elected to express the rate in terms of distance the cells had fallen at the end of 15 or 30 minutes. The volume of packed cells was measured in the hematocrit tube after centrifugation at 2,000 r.p.m. for 45 minutes. Total eosinophil counts‡ were done by drawing the blood to the 0.1 mark of the white cell counting pipette, and the cells in 32 squares (both chambers) of a Fuchs-Rosenthal chamber were totaled and multiplied by 1.56 to give cells per cubic millimeter of venous blood.

Skin tests were done in a shaved area at the base of the neck by injecting 0.02 to 0.05 c.c. of allergenic extract, appropriately diluted in normal saline containing 0.5 per cent phenol. The animals were restrained by a halter and lead rope only. No tranquilizer or other drug was administered.

*New Hope, Wirthmore Feeds Inc., Waltham, Mass.

†Vacutainer, Becton and Dickinson Co., Columbus, Neb.

‡Diluting fluid: saponin, 0.05 Gm.; eosin, 3 c.c. of a 2 per cent aqueous solution; and aqua des. q.s. ad 250 ml.

Table I

<i>Animal number</i>	<i>Date acquired</i>	<i>Breed, color, and sex</i>	<i>Estimated age</i>	<i>Estimated weight (lb.)</i>
2	March, 1961	Work horse, gray, female	20	1,400
3	April, 1961	Riding horse,* black, gelding	15	1,100
4	July, 1961	Tennessee walker, chestnut, gelding	18	1,000
5	November, 1961	Part Morgan, brown, female	14	1,000
6	December, 1961	Riding horse,* brown, female	15	1,100
7	July, 1962	Grade Shetland, brown and white, gelding	20	500

*Breed unknown.

Table II. Feeding of hay and the occurrence of heaves in six animals

<i>Animal No.</i>	<i>On hay</i>		<i>Off hay</i>	
	<i>Attacks</i>	<i>Duration in months</i>	<i>Attacks</i>	<i>Duration in months</i>
2	1	5.5	0	10
3	0*	5.5	0	10
4	7	2.25	1†	5.75
5	3	1.25	2* ‡	13.5
6	1	5.5	0	10
7	4	3	0	6
	16	23	3	54.25

*See text. Animal No. 3 was not observed to have an overt attack of heaves at any time and probably should not have been included in the study.

†Attacks occurred simultaneously in these animals when a bale of hay was opened next to the stalls in which they were stabled.

‡Attack occurred in early July while No. 5 was on pasture only and at a time when a hay field was being cut to windward of the pasture in which the animal was grazing.

RESULTS

Observations during a 15 month period on the six horses confirmed the prevailing view that heaves is associated with the feeding of hay. Hay was fed intermittently, and the number of attacks was noted. Table II gives a tally of the attacks during the periods in the aggregate that the animals were fed hay and during a longer total period when no hay was given. The appearance and disappearance of heaves was not a matter of disagreement among the various observers, and, indeed, most episodes were recognizable at a glance. As shown in Table II, there were 16 attacks among the six animals in a combined total period of 23 months while hay was fed, whereas there were only 3 attacks in a combined total period of 54 months during which hay was not fed. The attacks were not accompanied by fever. One animal (No. 3) did not exhibit unquestionable heaves at any time, although the feeding of hay was associated with cough and some increased respiratory movement. Wheezing was not heard. After hay was removed from the diet, the cough slowly disappeared, and respiration became quieter.

The circumstances under which the three attacks occurred when hay was *not* being fed are interesting. Animals 4 and 5 developed acute attacks of heaves within 20 minutes of each other shortly after a bale of hay was opened alongside

their stalls in the barn in which they were being kept. The third attack occurred on July 3, 1962, in Animal No. 5 at a time when it appeared to be thriving on a diet of fresh grass only. This attack coincided with the harvesting of hay in a neighboring pasture which was upwind. This was the only attack among the six animals during the four months that they were put out to pasture during the summer of 1962. It appears, therefore, that the ingestion of grass as such is not a cause of heaves and that exposure to the heaves-producing factor(s) in hay by way of the respiratory tract can lead to heaves.

The course of an attack of heaves as judged by inspection and auscultation in Animal No. 5 is crudely represented by the diamond-shaped area at the top of Fig. 1. The relation between the giving of hay and the onset of heaves is likewise shown. As heaves developed, the animal stopped eating and drinking. A very pronounced fall in eosinophils occurred on the second day of the attack along with a rise in hematocrit (presumably because of dehydration) and a fall in the sedimentation rate. A fall in sedimentation rate is to be expected with a rise in hematocrit, but other observations indicate that the fall may occur independently of changes in the hematocrit.

With subsidence of the attack the eosinophils rose and ultimately reached a level close to 1,000 per cubic millimeter, significantly exceeding the initial level. The hematocrit fell to a level close to that at the start, and the sedimentation rate rose to 20 mm. per 30 minutes, a value still below the normal range for the horse.

Enlarged frames from moving pictures taken at the height of the attack (Fig. 2) illustrate the characteristic dilatation of the nostril during inspiration

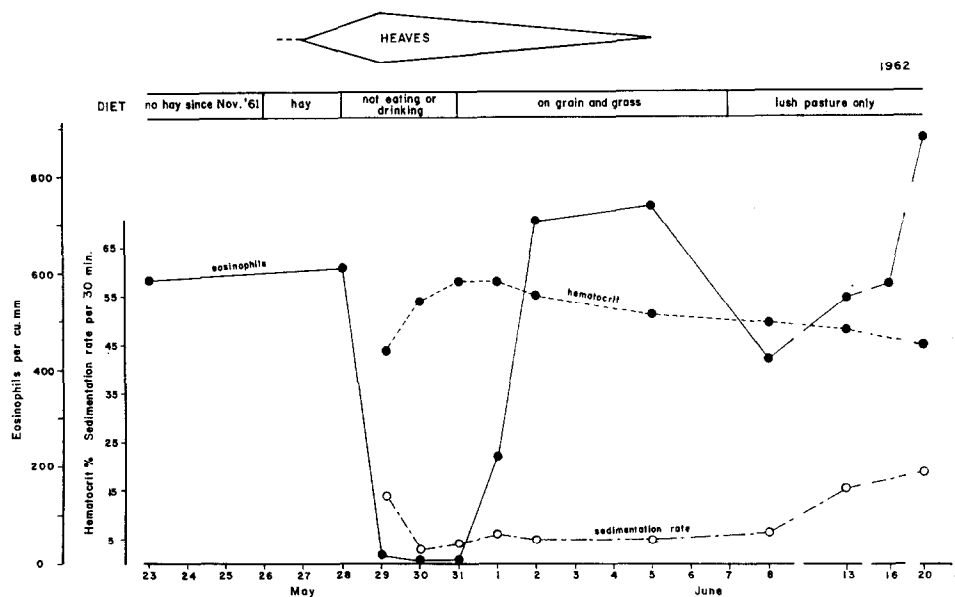
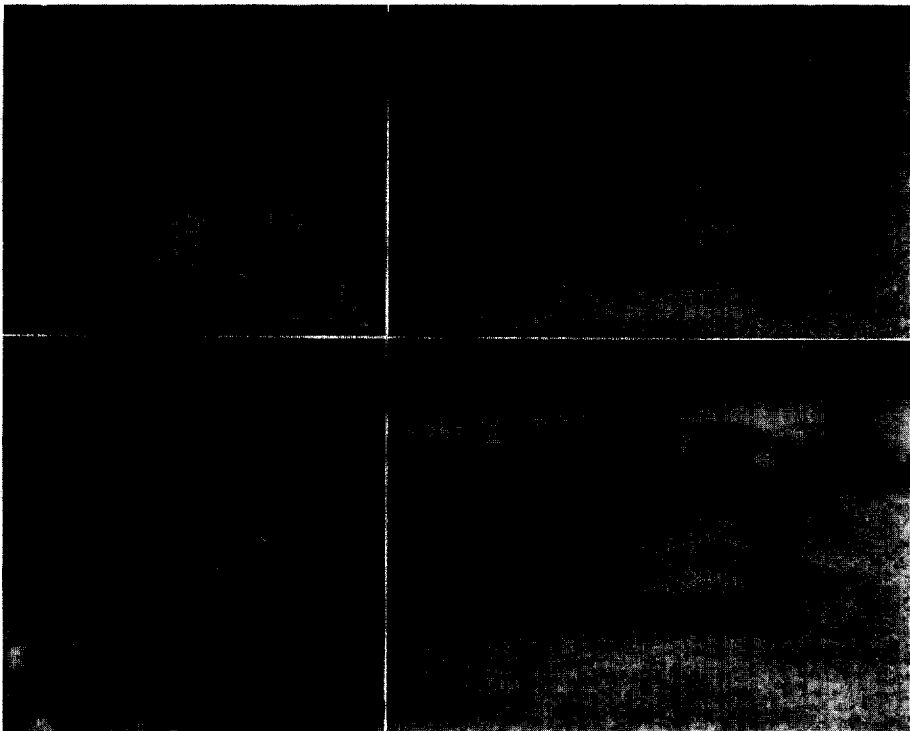


Fig. 1
Changes in the total eosinophil count, hematocrit, and erythrocyte sedimentation rate during an attack of heaves in Animal No. 5 are indicated.

**Fig. 2**

The appearance of Animal No. 5 during an attack of heaves is shown. Photographs were taken on May 30, 1962. The two upper frames were taken during inspiration, the two lower during expiration.

(top half) and prominence of the ribs and accentuation of the "heaves line" (lower half). The "heaves line," which runs horizontally, is produced by hypertrophy and forceful contraction of the external abdominal oblique muscles. The animal would walk only when urged. Similar changes were seen during the attack in this animal occurring coincidentally with the mowing of a hay field (Table III) on July 3, 1962, while the horse was on pasture.

Changes accompanying a milder attack in Animal No. 4 are shown in Table IV. During this attack the eosinophils fell from 421 to 125 per cubic millimeter, and there was little change in hematocrit. However, the sedimentation rate fell from 41 to below 10 mm. per 30 minutes.

Attempts to produce heaves by intense exposure of all six animals to concentrated timothy pollen extract by aerosol were unsuccessful. The exposure was carried out in an open field on a quiet day using a No. 40 DeVilbiss nebulizer and a 3 gallon tank hand-pumped garden sprayer as a source of air pressure. A three-foot length of 1 in. internal diameter Tygon tubing attached to the outflow orifice of the nebulizer served as a convenient means of delivering the aerosol to one nostril. The measured output at the end of the Tygon tubing lay between 0.1 c.c. and 0.2 c.c. per minute. The operator of the nebulizer timed aerosol production to coincide with inhalation. A few minutes were required

to accustom the animals to the noise and odor, but the aerosol was ultimately well accepted by all of them. A 1:10 (weight by volume) concentration of timothy pollen extract was given for not less than 5 minutes with no immediate or delayed response. One of the assistants, known to have hay fever in the grass pollen season, developed asthma in the course of the exposures.

The six horses with heaves and six animals without heaves were skin tested with the following extracts: birch, oak, plantain, timothy, and ragweed pollens, all in a concentration of 1:200 weight by volume; *Alternaria*, *Hormodendrum*, and *Penicillium* in a concentration of 1:200; house dust extract No. 1 (Endo Products, Inc.) in a concentration of 1:4,000 and No. 2 (Hollister-Stier) in a concentration of 1:1,000; and a "hay dust extract" in a concentration of 1:100 made of dust from a sample of the hay proved to be capable of inducing heaves.

No wheals were observed. The reactions consisted of smooth, raised areas of firm edema measuring up to 3 cm. in diameter. The first to appear were in the sites injected with histamine. These reached their peak in about 20 to 30 minutes and slowly subsided leaving a raised, flat, soft papule which disappeared over a period of 3 to 4 hours. There was no reaction to saline, and the reactions to the pollens were (for the most part) either absent or so minimal as to appear insignificant. Reactions to the molds, to house dust No. 1, and to the "hay dust" resembled the reactions to tests with histamine, except that they were slower to develop, reached their peak in about 3 to 4 hours, and persisted for 5 to 6 hours. No significant differences were observed between the group of 6 horses

Table III. Occurrence of heaves in Animal No. 5 while on pasture in July, 1962, showing associated hematologic changes

	July, 1962										
	1	2	3	4	5	6	7	8	9	10	11
Heaves	0	?	++	++++	+++	+++	++	+	±	-	±
Eos/mm. ³	-	-	613	90	1.5	5	17	-	2,190	-	2,900
Hematocrit (%)	-	-	40	39	47	45.5	49	-	43	-	-
Sed. rate, mm.	-	-	46	17.5	7.5	8	7.5	-	11.5	-	-
W.B.C./mm. ³ × 10 ³	-	-	11.1	14.5	18.5	16.9	15.3	-	12.4	-	-

Severity of heaves: 0 represents no heaves; + just recognizable; ++ readily recognizable but normal spontaneous activity and appetite; +++ obvious heaves and some decrease in activity and appetite; ++++ little spontaneous movement and refusal of food and water. Eos, eosinophils.

W.B.C., white blood cells.

Sed. rate, fall in red cells in 30 minutes.

Table IV.* Hematologic changes in Animal No. 4 during an attack of heaves

	January, 1963							
	14	15	16	17	18	19	21	23
Feeding of hay	0	+	+	0	0	0	0	0
Heaves*	0	++	+++	+	±	+	0	0
Eos/mm. ³	421	-	125	519	519	399	367	329
Hematocrit (%)	41	-	44	39	40	40	41	36.5
Sed. rate, mm.	41	-	6	9	37	45	17	53
W.B.C./mm. ³ × 10 ³	8.1		8.2	6.9	7.6	9.5	9.4	6.8

*See footnote for Table III.

with heaves and a group of six "normal" animals. Thus, the hay dust, the mold extracts, and house dust No. 1 elicited similar reactions in the skin of all the animals tested. The most intense reactions were obtained with the hay dust extract and house dust No. 1 to which all the animals reacted. Less intense reactions were obtained with the mold extracts, but all animals reacted to at least one of the three, and five reacted to all. Reactions to house dust extract No. 2 were also irregular and of low intensity. The relation of these reactions to heaves could not be ascertained. It appears likely, however, that many or perhaps all stabled and hay-fed horses, repeatedly exposed as they are, become skin reactive to the allergenic components in hay, and these are also present in house dust extract No. 1.

DISCUSSION

We were impressed by the episodic nature of heaves in the group of animals under observation; the striking association between the feeding of hay and the occurrence of attacks; the occurrence of attacks in two animals shortly after a bale of hay was opened close to them at a time when no hay was being fed; the obstructive nature of the respiratory difficulty, and the absence of evidence of infection. These features are consistent with, but do not establish, the hypothesis that heaves is a form of respiratory allergic disease induced by the inhalation of one or more components of hay. However, ingestion of these heaves-producing components (without inhalation) was not excluded as a cause of heaves. With the exception of anorexia in Animal No. 5 and the passage of gas often noted with paroxysms of coughing, gastrointestinal manifestations were not a feature of the attacks.

Although the association between the occurrence of heaves and the feeding of hay was clear, the feeding of hay regularly and predictably produced heaves only in Animals Nos. 4 and 5 and possibly 7. Heaves appeared and subsided in one other animal (No. 6), even though the feeding of hay was continued, and only appeared in a fifth (No. 2) after prolonged feeding. Furthermore, even though heaves was produced with regularity in animals No. 4 and 5 by the feeding of hay, the period of feeding required to produce an attack varied on different occasions from a few hours to several days. Thus it appears probable that the heaves-producing capacity of hay varies from bale to bale and even from one part of a bale to another. It is also probable that animals vary from one time to another in their susceptibility to heaves. The "unpredictability" of heaves in the group as a whole during the feeding of hay was reminiscent of the irregularity with which overt symptoms of asthma appear in asthmatic patients, even when they are presumably exposed to substances known to be capable of causing asthma.

Among the numerous components of hay, the following warrant investigation as possible causes of heaves: (1) molds, widely regarded as the cause of heaves; (2) bacteria; (3) grass or other pollens; (4) insects and mites, and (5) particles of grass or other plants in hay. A single experiment in which timothy pollen extract was administered by aerosol did not produce heaves. Further experiments along these lines are in progress.

Nothing is known regarding the relevance of skin testing in the horse with extracts made from the above-mentioned components of hay or other substances as a means of determining the cause or causes of heaves. Wheals of the type characteristically seen in man were not produced in the 12 animals tested, the reactions being most pronounced about 4 hours after the intracutaneous injection. However, the reactions obtained were of some interest, especially the similarity of the reactions obtained with hay dust and house dust extract No. 1.

A striking fall in the eosinophil count and a slowing of the sedimentation rate accompanied the severe attacks of heaves in which measurements were made. In Animal No. 5 hemoconcentration secondary to dehydration accounted at least in part for the decrease in sedimentation rate, but in another animal a decrease occurred without hemoconcentration. Thus it appears that the sedimentation rate may decrease independently of hemoconcentration during an attack of heaves, perhaps because of a decrease in fibrinogen or some other globulin fraction in the plasma.

The observed fall in the total eosinophil count of the blood during attacks of heaves can be explained in at least two ways. First, an attack of heaves may impose physiologic stress of a degree which would cause increased production of steroids by the adrenal glands and thereby depress the eosinophil count. Second, if heaves is indeed an allergic disease, eosinophils may accumulate in the tissues, presumably the lungs but perhaps elsewhere, at the expense of circulating cells. The sharp rise in eosinophils as the attack subsides would be attributable in either case to increased liberation of eosinophils by the bone marrow as the stimulus to eosinopenia subsides.

The relation of the observed attacks to chronic alveolar emphysema, widely regarded as the outstanding pathologic feature of heaves, requires comment. The observations presented herein became possible because an alternative to the feeding of hay was available, and hay could be fed or withheld at will. Not only did manipulation of the diet bring the relation between the feeding of hay and the occurrence of attacks into sharp relief, but subsidence of attacks on the withdrawal of hay was repeatedly observed. This indicated that the manifestations induced by feeding hay were reversible, and therefore the pulmonary changes giving rise to the attacks were also reversible. Whatever the role played by chronic alveolar emphysema in the production of heaves, another process, reversible and somehow mediated by hay, was operative in our animals. Had hay been fed without interruption, the pulmonary disease would probably have appeared as chronic and progressive, and it seems unlikely that Animal No. 5 would have survived for long. If, as seems possible, an episode of heaves can leave in its wake a degree of irreversible damage, the end result of recurrent or protracted attacks might well be widespread emphysema. In this case, emphysema would be regarded as secondary, and a variable, transient, or reversible process is the primary lesion of heaves. Since atropine is often given to relieve the manifestations of heaves,¹ smooth muscle spasm probably constitutes one component of the disease. Reversible obstructive pulmonary disease accompanied by smooth muscle spasm is reminiscent of allergic obstructive disease as it occurs in man and the guinea pig. Since one of the inciting agents, some component

of hay, is well tolerated by most horses, allergy to this component among horses with heaves appears to explain the pathogenesis of the disease.

SUMMARY

Observations in six horses with heaves established a clear relationship between attacks of heaves and the feeding of hay. Severe acute attacks were accompanied by striking changes in the eosinophil count and the sedimentation rate. The variation in the severity of heaves in relation to the feeding and withholding of hay is accounted for by assuming that attacks result from a transient obstructive lesion in the bronchial tree or lung caused by hypersensitivity to some component of hay.

The observations strongly suggest that heaves is a respiratory allergic disease in the horse. The relation of heaves to pulmonary emphysema in the horse is discussed.

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