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THE TREATMENT OF COLIC IN THE HORSE BY  
INTRAVENOUS INJECTIONS OF CHLORIDE OF  
BARIUM.<sup>1</sup>

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THE use of chloride of barium in veterinary medicine was suggested to Dieckerhoff by the symptoms produced in two horses which had accidentally partaken of the salt. These animals, which worked in a railway station, were poisoned by licking the floor of a van on which some chloride of barium had fallen from the sacks containing it.

After studying the action on horses of chloride of barium administered through the medium of the digestive tract, the connective tissue, and the veins, Dieckerhoff finally chose the method of intravenous injection for treating colic, and in 1895 described this new treatment in an article in which he summarised the results of his first series of fifty-one observations. The investigations hitherto reported on the action of chloride of barium refer to its administration by the mouth in horses and the larger ruminants, and to its use in the treatment of different bovine disorders, such as dyspepsia, constipation, tympanites, and post-partum paralysis. The latter I leave on one side, intending at present to deal only with the intravenous use of this material in treating equine colic. Some months after the publication of Dieckerhoff's article his assistant, Brass, described a second series of 136 cases of colic treated by intravenous injections of chloride of barium. Of these, twelve horses died, that is, 9 per cent. The lesions found on *post-mortem* examination explained these fatal issues. Seven had twist of the large intestine, two volvulus of the small

<sup>1</sup> Translated from the "Recueil de Méd. Vét.," 15th October 1902.

intestine, one a hernia of the hiatus of Winslow, and one enteroperitonitis, the small intestine being strangulated by the epiploon. The doses injected into the jugular vein by Dieckerhoff and Brass varied between  $7\frac{1}{2}$  and 19 grains. To heavy horses they several times gave doses of 22 to 30 grains. In 187 patients no fatal result referable to the treatment occurred.

When I introduced this new method of treating colic to the Central Society of Veterinary Medicine I had used it on thirty-two horses, injecting doses of the chloride varying between 5 and 18 grains into the jugular. Of these thirty-two patients, three died; two had rupture of the stomach, and one twist of the small intestine. No alarming symptoms occurred, there was no indication of toxic action, and the rapid effects produced strongly impressed me. Some minutes after injection the contents of the rectum were expelled, then followed solid, semi-liquid, and gaseous evacuations, repeated at more or less frequent intervals for one-half to one hour. The peristalsis and liquid secretions of the bowel were increased much more rapidly than by eserine, pilocarpine, or arecoline.

My own observations, like those made up to that period in the Berlin clinique, appeared to show that, despite its toxicity, chloride of barium could be introduced into the veins in the doses above indicated without danger, provided these doses were approximately proportioned to the size or weight of the animals; that is to say, for small animals the dose should vary between 5 and 10 grains, for those of medium size  $7\frac{1}{2}$  and 14 grains, and for large animals between 12 and 18 grains.

None of the veterinary surgeons who used chloride of barium in the manner above suggested reported any fatal case or declared themselves disappointed with the results obtained. Dahlenburg treated thirty-two horses affected with colic by the intravenous injection of doses similar to those first suggested by Dieckerhoff. Having seen no serious symptoms attributable to the toxicity of the drug, he suggested that the deaths reported by others were due to errors in the solution or in estimating the dose. In forty-eight cases Grüner injected into the jugular doses of chloride varying between 12 and 15 grains without producing any alarming results. In two cases a dose of 30 grains and in another a dose of 45 grains only produced the usual effects, though in an intensified form. In the clinique of the Veterinary School of Buda-Pesth Hutyra during 1897 treated 191 horses by intravenous injections, the doses varying between 7 and 18 grains. The smaller dose was given whenever any sign of weak heart was observed in the subject. He reported no cases of rapid death, and no symptoms suggesting a toxic action in the medicine. Angerstein, Carrey, Lehnert, and Petersen have published less favourable reports.

But large quantities injected in one dose, particularly in concentrated solution, have produced fatal effects certainly due to the action of chloride of barium on the heart. Whatever Grüner, Plattner, Dahlenburg, and others may say, these results were due neither to impurities in the drug nor to changes in the solution, nor, it would seem, to errors in the method of administration. There is no doubt whatever that the majority were a result of this toxic character of chloride of barium and of its very special action on the

heart. Injected rapidly and in full doses into the blood, the chloride of barium reaches the left heart and cardiac arteries in an insufficiently diluted state, and by its direct action on the cardiac ganglia or on the muscular fibres may produce tetanisation of the heart and almost instantaneous death. In the majority of cases where death followed a few moments after injection the doses varied between 12 and 19 grains. Animals have died after even smaller quantities: Siebert's case was killed by 12 grains, Mollereau's by 9 grains, and Ries's by 7 grains. In France, the two fatalities mentioned by Mollereau appeared to suggest that chloride of barium is an extremely dangerous remedy which in practice should be avoided. But a study of the total number of cases hitherto published shows that in general its injurious properties have been greatly exaggerated, and that of the horses for whose sudden death it was undoubtedly responsible many were already on the point of dying or were very seriously affected by the absorption of toxic substances from the intestine.

Close observation shows that fatal results most often follow when the animals are in an advanced stage of the disease, when they show marked circulatory disturbance, the pulse and heart being very rapid and feeble, or the violence of the heart being in marked contrast with the feebleness of the pulse, or, again, when the patient is suffering from some old-standing cardiac mischief. In such cases, therefore, it is wise to administer only small doses, or to divide the dose into several parts.

Experience has shown that the injection of small doses, repeated in accordance with the progress of the case, produce all the good effects to be obtained from the drug. Since 1896 I have practised the following method: A first injection of  $3\frac{1}{2}$  to 7 grains is given, followed, in a quarter of an hour, by another of 3 to 5 grains, which if necessary can be repeated fifteen or twenty minutes later. In the advanced cases of stoppage of the bowel, where the animal is already under the influence of intestinal poisons, it is wise not to exceed doses of 4 to 6 grains repeated three or four times at intervals of a quarter of an hour to twenty minutes.

Since 1896 I have treated, or caused to be treated, in the above way 162 cases of colic in the horse. In a certain number I have also bled the animals, applied stimulant applications or douches of cold water to the abdomen, and have given cold enemata. Of these animals twenty-one (13 per cent.) died, but I have never noted any toxic effects produced by the chloride of barium.

During the month of September last I systematically treated all horses sent here on account of colic by such injections. The solution used was of a strength of 1 in 30. Two or three injections were made at intervals of twenty to thirty minutes: in large animals a first injection of 12 cc. containing 6 grains of chloride was given, followed by one or two others of 9 to 10 cc. containing 15 grains; for horses of medium size, a first injection of 10 cc., followed by one or two others of 8 cc.; for small animals, a first injection of 8 cc., and one or two others of 6 cc. A review of the clinical records sent me by MM. Pécard and Rebeu, students in the clinique of pathological medicine, show that these small doses are sufficient to rapidly increase peristalsis and intestinal secretions.

*Case I.*—Dappled grey stallion, thirteen years old. This horse's daily ration consisted of 20 litres of oats, 10 to 12 of which were given at mid-day. He was very subject to colic, and had been attacked several times during the summer of 1901. About two o'clock on the afternoon of the 2nd September, while at a walking job, he showed signs of colic, and was brought to the School.

The abdominal pain was moderate. The animal appeared tired and depressed, scraped with the fore feet, turned his head towards his flank, switched his tail, and from time to time lifted his legs or lay down cautiously, but was restless and soon rose again. The conjunctiva was slightly injected, the pulse rapid and full. The inguinal region on each side was normal.

At 2.15 P.M. 12 cc. of the above solution, containing 6 grains of chloride of barium, were injected into the jugular vein, and the patient was exercised. At the end of three minutes attempts were made to defæcate, and were soon followed by the passage of hard-coated fæces. Solid material was again passed on several occasions at intervals of five to ten minutes. The pain continued, without, however, becoming more severe. At 3.40 P.M. and 4.10 P.M. two other injections of 10 cc. were made. The animal passed semi-liquid material and gas. He was somewhat upset for an hour longer, then the pain gradually ceased. Left at liberty in his box, he lay down, but no longer showed any sign of discomfort.

*Case II.*—Light grey gelding, ten years old. After a moderate day's work, this animal was attacked with colic during the night of the 4th September, and was brought to the School at 6 A.M. next day. Intestinal pain was severe; the animal was very restless, lay down, rolled, and struggled violently at frequent intervals. The skin was moist, the horse sweated freely in the flanks and under the arms; the pulse was rapid and feeble, the mucous membranes somewhat pale, and the limbs cold. Nothing abnormal was discovered on rectal exploration.

Six litres of blood were drawn from the jugular. Oil of turpentine was rubbed into the sides of the chest, and mustard was applied over the abdomen; the patient was then walked about.

At 8 A.M., as it was no better, 12 cc. of the solution, containing 6 grains of chloride of barium, were injected, followed at intervals of twenty to thirty minutes by two others of 9 cc. Evacuations commenced six minutes after the first injection. They were abundant, and gradually became more and more liquid. Improvement followed rapidly on the action of the medicine; towards ten o'clock it was perceptible, and gradually became more marked. At 12.30 P.M. the animal had completely recovered, and left the School.

*Case III.*—Black gelding, nine years old. Attacked with colic during the morning of the 13th September; brought to the College at 3.30 P.M. The animal was very restless. The mucous membranes were somewhat pale, the pulse slightly accelerated.

At 3.40 P.M. it received an injection of 10 cc. of the solution, after which it was exercised. At 3.55 P.M. it passed fæces, covered with a thick layer of mucus. At 4.10 P.M. 8 cc. of solution were injected. At 4.15 semi-liquid material was passed, and the bladder was emptied. At 4.30 a further injection of 8 cc. was made. At 4.45 P.M. soft fæces mixed with mucus were passed.

The animal was in less pain and did not attempt to roll. At 5.15 P.M. there was an abundant evacuation, and a little later the animal staled.

The horse recovered, and left during the evening.

*Case IV.*—Bay gelding, six years old. At mid-day of the 21st September, after a harder morning's work than usual, this animal returned to the stable, drank freely of water, and ate 7 litres of oats. As it showed colic towards one o'clock, it was wiped down, given an anodyne drink, and exercised. Becoming worse, it was brought to the School at 3 P.M. It was then in a somewhat grave condition; very restless, wet with sweat, the pulse rapid, and the mucous membranes injected.

At 3.15 P.M. an injection of 10 cc. of the solution, containing 5 grains of chloride of barium, was given. In four minutes the contents of the rectum were expelled, and evacuations continued at short intervals. In twenty minutes a second dose of 8 cc. was given, and half an hour later a third of equal amount. This last was followed by the repeated passage of softened fæces and of gas. Up to that time the symptoms had remained acute and alarming. They afterwards diminished, and the animal rapidly recovered.

*Case V.*—A dappled grey stallion, ten years old. At 6 A.M. on the 22nd September, after having eaten 10 litres of oats, this horse was taken to work. It did not show any uneasiness during the morning. At mid-day it ate 6 litres of oats and half a truss (*une demi-botte*) of hay. Towards two o'clock it had a violent attack of colic, and at four was brought to the School.

In addition to the usual signs of acute indigestion we noted acceleration of the pulse, slight injection of the conjunctiva, and a little gaseous distension. The inguinal region on each side was normal.

At 4.10 P.M. 10 cc. of the solution, containing 6 grains of chloride of barium, were injected into the jugular. At 4.20 P.M. solid fæces were passed. At 4.40, after a second injection of 10 cc., there were repeated and copious passages of semi-liquid fæces, in which the watery constituents predominated. From this time onwards the animal became quiet and ceased to attempt rolling. At six o'clock it left cured.

*Case VI.*—Bay gelding, nine years old. This horse, which was delivering parcels, was taken ill with colic about ten o'clock on the morning of the 23rd September. The symptoms, though at first trifling, gradually became more severe. The horse was unharnessed, rubbed down, exercised, and given a little mash. In the afternoon the attack became violent, and the horse was brought to the College.

It showed very violent pain, and when down rolled about. The conjunctiva was rather pale, the pulse normal as regards force, but somewhat accelerated.

At 3.45 P.M. the animal received an injection into the jugular of 10 cc. of the solution, containing 5 grains of chloride of barium. Oil of turpentine was rubbed into the skin of the abdomen. In ten minutes fæcal material, containing considerable quantities of mucus, was passed. Two other injections of 8 cc. were given at intervals of half an hour. The animal passed soft fæces, mixed with fragments of mucus, and twice urinated.

Towards 5 P.M. the attack diminished, and the horse no longer attempted to lie down. It still turned its head towards the flank, but showed no other sign of pain. During the evening it was sent home cured.

*Case VII.*—Bay stallion, ten years old. Attacked with colic during the morning of the 26th September, and brought to the School at 10 A.M.

The patient showed signs of acute abdominal pain. The conjunctiva was slightly injected; the pulse was of normal volume but somewhat frequent. Examination of the inguinal region and of the posterior abdominal region per rectum revealed nothing abnormal.

At 10.10 A.M. 10 cc. of solution, containing 5 grains of chloride of barium, were injected, and the horse was walked about. Five minutes later it made efforts to defæcate, and ten minutes afterwards passed solid excreta. At 10.30 a second injection of 8 cc. was given. During the ensuing quarter of an hour there were three abundant liquid evacuations. Towards 11 A.M. the symptoms abated, and the animal no longer attempted to lie down. It was left at liberty in its box, and an hour later showed no sign of pain.

*Case VIII.*—Grey mare, twelve years old. At 3 P.M. on the 30th September this animal showed colic, and at 4 P.M. was sent to the School.

She attempted to roll. The conjunctiva was pale, the pulse full, the respiration rapid. The flank was slightly distended with gas.

At 4.30 P.M. 10 cc. of solution were injected into the jugular. In five minutes fæces and urine were passed, followed five minutes later by semi-liquid fæces.

At 4.50 P.M. a second injection of 8 cc. of the solution was made. Ten minutes later large quantities of liquid fæces were passed. The animal at once appeared relieved. It was sent home about 5.30 P.M.

*Case IX.*—Bay gelding, twelve years old. On the morning of the 1st October this animal received 7 litres of oats; it worked until mid-day, when it consumed 7 litres more, and, having slipped its head-collar, ate part of another horse's food. It was attacked with colic towards 2 P.M., and was sent to the College at 5 P.M.

It was greatly distended with gas, and continually looked towards its flank, lay down from time to time, and made ineffectual efforts to defæcate. The conjunctiva was pale, the pulse strong, the respiration slightly accelerated.

At 5.10 P.M. 10 cc. of the solution were given. In five minutes the animal twice passed fæces. At 5.30 a further injection of 8 cc. solution was given. Five minutes later there was an abundant passage of liquid excreta.

*Case X.*—Dappled grey stallion, eight years old, 16 $\frac{3}{4}$  hands high. This animal returned home on the 1st October at 11 P.M., and ate its ordinary allowance of food. Next morning at 4 A.M. it had its breakfast. Towards 8 A.M. it showed colic. Despite free bleeding it became worse. At 9 A.M. it was brought to the School.

It was very restless, lay down, struggled violently, and occasionally eructated. The conjunctiva was injected, the pulse feeble, the respiration rapid. Examination of the genital organs showed nothing abnormal.

At 9.30 A.M. it received an injection of nine-tenths of a grain of nitrate of pilocarpine, followed, ten minutes later, by an injection of four-tenths of a grain of sulphate of eserine and by repeated enemata of soap and water containing sulphate of soda. Salivation was abundant, but the bowel failed to act and pain remained acute. At 10 A.M. a mustard plaster was applied to the abdomen and oil of turpentine was rubbed into the skin over the lumbar region. The animal struggled so violently that it was difficult to approach it.

At 11 A.M. 10 cc. of the solution were injected into the jugular. In five minutes two evacuations occurred. At 11.20, 8 cc. of the solution were injected. The animal soon afterwards passed gas and frequent borborygmus was heard. In ten minutes it passed semi-liquid fæces and five minutes later liquid material. Finally the pain diminished, and the other symptoms gradually disappeared.

Given in divided doses, chloride of barium appears very active, prompt in its effects, and without danger. At the Berlin School Brass and Witt have given more than 30,000 injections without a single fatal result and without symptoms of poisoning. No accidents occurred at the Claye Farm, where M. Cluzet treated 445 cases of colic among the horses of the Paris Omnibus Co. with doses of 4 grains repeated two or three times at intervals of a quarter of an hour to half an hour; and almost all practitioners who have continued to employ this drug with the precautions just suggested report having had excellent or at least very satisfactory results.

One remark may be added concerning the method of injection. In addition to injecting the solution slowly, it is important to avoid introducing air into the vein. Although the passage of two or three bubbles is not of consequence, any considerable quantity might lead to death. Such a result would certainly be exceptional, but its possibility must not be lost sight of, even although experience has shown that the injection of considerable quantities of air does not commonly produce any accident. After describing the results of his injections of chloride of barium, Grüner adds that he has introduced six syringes full of air into the horse's jugular without observing any peculiar symptoms whatever. This experiment and those just alluded to are only in the nature of negative facts. Recorded cases clearly show that the entry of a certain quantity of air into the horse's jugular may be very dangerous, if not fatal.

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## EXPERIMENTAL RESEARCHES REGARDING BLACK-QUARTER.<sup>1</sup>

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In a previous article we have described some researches regarding immunisation against black-quarter by means of pure culture, protective serum, and the combined employment of cultures and serum. We shall here describe, together with some new experiments, the results obtained by employing these different methods of vaccination in practice.

<sup>1</sup> Translated from the "Annales de l'Institut Pasteur," December 1902.