J. Vet. Med. A **48,** 465–473 (2001)

ISSN 0931–184X

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Determination of a Gravity and Shock Score for Prognosis in Equine Surgical Colic

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With 4 figures and 5 tables

(Received for publication June 14, 2000)

Summary

A retrospective study evaluated 200 surgical colic cases. A gravity score (GS) based on four clinical parameters estimating intestinal obstruction (rectal palpation, borborygmi, abdominal distension, pain) and classified into three categories was established and tested to determine if it could evaluate prognosis. A shock score (SS) based on six parameters was also attributed to each case. The overall survival rate was 54 %. The statistical analysis showed a significant ($P < 0.01$) difference in the survival rate in the different categories of the GS, as well as in the categories of the SS. A multivariate logistic regression model showed that horses with GS 3 are 10.6 times more likely to die than those with GS 1. A model combining the two scores showed an odds ratio of 7.1 for GS 3 versus GS 1, and for SS 3 versus SS 1, the odds ratio was 7.2.

Introduction

Acute abdominal disease (colic) is the major cause of morbidity and mortality in the horse (Cohen et al., 1995). Prospective studies of equine colic point to incidences of 10 colic cases per 100 horse-years in the study of Tinker et al. (1997) and even 26 cases in another study by Uhlinger (1992). The proportion of mortality due to colic is greater than the proportion of any other cause of death, including old age and injury (Tinker et al., 1997).

Surgical colic cases, especially, present poor survival rates, from only 34 % (McCarthy and Hutchins, 1988) or 35 % (Ebert, 1994a) to 53.6 % (Shires et al., 1986) and 56 % (Parry et al., 1983c) up to 69.7 % (Puotunen-Reinert and Huskamp, 1985). Several authors also agree that small intestine lesions have poorer outcome because of the high percentage of strangulated lesions compared with large intestine obstructions (Parry, 1983; Pascoe et al., 1983; McCarthy and Hutchins, 1988; Ebert, 1994a).

Due to the high costs of surgery and intensive care, one can easily understand the importance of giving a prognosis for a colicky horse. It is difficult to specify because of the multiple factors to consider, including the type and severity of the primary lesion and the secondary changes complicating it (Huskamp, 1973). Several studies estimated the prognostic value of individual variables used in the assessment of equine colic cases. The best prognostic variables were commonly those estimating the integrity of cardiovascular

function (Moore et al., 1976; Gay et al., 1977; Parry et al., 1983a, 1983b; Puotunen-Reinert, 1986; Orsini et al., 1988), but variables estimating the amount and intensity of devitalized bowel by abdominal fluid analysis (Allen et al., 1986; Reeves et al., 1989; Freden et al., 1998) were also prognostically useful. The variables heart rate, packed cell volume, blood lactate concentration and capillary refill time were recognized as significant variables by nearly every author. Other parameters, like systolic arterial pressure, were highly significant in some studies (Gay et al., 1977; Parry et al., 1983a), but non-significant in others (Ebert, 1994b). The results of the studies depend on the number and type of cases.

There are only very few studies that validate the results on another population (Reeves et al., 1988; Furr et al., 1995). More and more authors try to define models by logistic regression using several parameters in order to increase the accuracy in predicting the outcome (Puotunen-Reinert, 1986; Reeves et al., 1989; Furr et al., 1995; Ebert, 1995).

Only a few authors use clinical variables estimating intestinal obstruction or function for prognosis. The variables used were intensity of colic signs (Puotunen-Reinert, 1986; Ebert, 1994b) and the intensity or frequency of abdominal sounds (Kalsbeek, 1975; Stashak, 1979; Reeves et al., 1989; Ebert, 1994b).

We often observe colicky horses which only show slight shock symptoms in spite of severe intestinal lesions. This could be due to treatment with strong anti-inflammatory drugs or due to the only ischaemic period before reperfusion at the time of reception of the horse. We often remark that severe shock symptoms appear at the time of reperfusion after repositioning during surgery. So we wondered if means other than shock symptoms could evaluate prognosis at the time of arrival of the horse at the clinic. The aim of this study was to define clinical parameters estimating intestinal obstruction which could be beneficial for prognosis.

Materials and Methods

Data were collected on 200 surgical colic cases referred to our clinic during the last 4 years (only cases with sufficient data and with precise diagnosis were retained, cases euthanized for economic reasons were eliminated from the study). The ages ranged from 4 months to 25 years with a mean of 9 years. The population was composed of 98 mares, 72 geldings and 30 stallions. The breed was essentially Warmbloods (151), with 16 ponies, nine Trotters, six Thoroughbreds, five Pintos, four Arabs, four draft horses, two Anglo-Arabs, two Appaloosas and one Andalusian. The horses weighed from 75 to 850 kg with an average of 516 kg.

On arrival, the same protocol for acute abdominal emergency reception was applied to each horse by the same staff, including history of colic signs, clinical evaluation, rectal palpation, gastric intubation, paracentesis, systolic arterial pressure measurements, haematological and biochemical blood tests. A gravity score (GS) and a shock score (SS) were attributed to each case.

The GS was based on four parameters estimating intestinal obstruction [mechanical obstruction (by impaction, displacement, incarceration, torsion) of the intestinal lumen not permitting normal function], which are currently used to distinguish the medical and the surgical character of colic. These parameters were rectal palpation, frequency of borborygmi, abdominal distension and severity of pain and they were classified into three categories. The highest value of any one of the four parameters determined the final GS. In category 1, rectal exploration is possible, there is only local and mild distension of the bowel, borborygmi are normal, there is no external abdominal distension and pain is absent or low and responding to slight analgesia (p. ex. Dipyrone). In category 2, rectal exploration is more difficult, the bowel is distended in one side of the abdomen, borborygmi are diminished at least in one flank, abdominal distension and pain are moderate, but pain is still responding to treatment with stronger analgesics like flunixine meglumine. In category 3, rectal exploration is impossible, there is severe distension, borborygmi are absent, the abdomen is highly distended and pain is severe and continuous [only responding for a short time (or even not) to strong analgesics like alpha-2 agonists and butorphanol] or the horse is already depressed (see Table 1). As all the horses presented to the clinic had had anterior treatment by the referring veterinarian, pain was categorized with consideration of the administered treatment.

For each category of the GS the time elapsed between the onset of colic and the referral was recorded and compared by a non-parametric test and significance was observed when $P < 0.05$.

A SS was also attributed to each case and was composed of six cardiovascular parameters classified into four categories (absent, mild, severe, irreversible). These parameters were heart rate, respiratory rate, systolic arterial pressure, packed cell volume, blood lactate concentration and blood urea nitrogen. The highest value attributed to a case determined the SS and if certain values were not available then the index was obtained using the others (see Table 2 for the precise values of the categories).

The main types of lesion observed in surgery were also listed.

Survival rate prevalence (number of surviving horses over total number of horses) was computed for each colic localization (large or small intestine), for each category and each component of the GS and for the SS. The null hypothesis of identical survival rate in each category of the two scores was tested with Chi-squared tests. Heart rate and packed cell volume were averaged separately for dead and surviving horses.

A multivariate logistic regression model was used to determine possible relationships between survival rate on the one hand and colic localization (large or small intestine), SS (1–3), GS (1–3), heart rate and packed cell volume on the other. In order to find the most parsimonious model that best fit the data, a stepwise procedure was used (logistic procedure by SAS). The fit of each successive model was evaluated by the deviance and the Aitken Information Criteria. The odds of dying were defined as the probability of dying divided by the probability of surviving for horses with the same value for one variable under study. The odds ratio was the ratio of the odds of dying and the odds of surviving. The significance level for the statistical analysis was $P < 0.01$.

Results

The cases were composed of 101 large intestine obstructions, of which 44 were strangulated, and 99 small intestine obstructions, with 96 strangulated lesions (Table 3). The overall survival rate was 54 %. Survival rates were significantly different between small (42.4 %) and large intestine (65.3 %) obstructions. The survival rate for the non-strangulating large intestine obstruction was 87.7 %; for the strangulating large intestine obstruction, it was 36.4 %; and for the strangulating small intestine obstruction, it was

Table 1. Determination of the three categories of the gravity score

	1	2	3
Rectal palpation	Exploration possible, local mild distension	Exploration partially impossible, distension	Exploration impossible, severe distension
Borborygmi	Normal	Diminished, one flank	Absent
Abdominal distension	No	Mild, one flank	High
Severity of pain	Absent, low	Mild	Severe, depression

Table 2. Determination of the four categories of the shock score

	1	2	3	4
Heart rate (bpm)	<60	60–80	80–100	>100
Respiratory rate (bpm)	<25	25–35	35–45	>45
Packed cell volume (%)	<45	45–55	55–65	>65
Systolic arterial pressure (mmHg)	>110	90–110	70–90	<70
Blood lactate concentration (mg/dl)	<75	<75	75–100	>100
Blood urea nitrogen (mg/dl)	<40	40–55	55–70	>70

bpm, beats per minute.

41.7 %. The number of cases and the distribution gave a sufficient number of cases for statistical analysis in the different categories of the GS and SS for the large and small intestine. Table 4 shows that the numbers of cases of large and small intestine obstruction in the different categories of the GS were similar.

The main lesion types for the small intestine were incarceration in the epiploic foramen ($n = 51$), volvulus ($n = 20$), strangulating inguinal hernia ($n = 11$), strangulating lipoma ($n = 10$) and various types ($n = 7$); and for the large intestine, left dorsal displacements of the left colon ($n = 28$), right dorsal displacements of the left colon ($n = 24$), torsion or volvulus of the ascending colon ($n = 32$), various lesions of the descending colon ($n = 9$) and others ($n = 8$) were encountered.

The time elapsed between the onset of colic signs and the referral was recorded for 180 cases only because of insufficient data for the other cases; and five horses of GS 2 had onset of more than 3 days, so these values have not been considered. The mean values of colic signs were 10 ± 8 h (2–36 h, $n = 30$) for GS 1, 13 ± 9 h (2–48 h, $n = 79$) for GS 2 and 14 ± 10 h for GS 3 (2–48 h, $n = 71$), and no significant differences were seen. When the data were split into survivors and non-survivors, there was only a significant difference for GS 3 (10 ± 7 h for survivors, $n = 20$ versus 16 ± 11 h for non-survivors, $n = 51$).

The survival rate was significantly different across the categories of the GS, where the survival rate was 80 % for GS 1, 66 % for GS 2 and 27.3 % for GS 3. The odds of dying were estimated to be significant and 10.6 times greater in horses with GS 3 compared with horses with GS 1. For GS 2, the odds ratio was not significant. Furthermore, there was a significant relationship between survival rate and the parameters forming the GS (rectal palpation, frequency of borborygmi, abdominal distension and severity of pain). Figure 1 shows the significant relationship between survival rate and the parameters of the GS. The survival rate for the most frequent problem, incarceration in the epiploic foramen, was 89 % for GS 1, 50 % for GS 2 and 13 % for GS 3.

For the SS, the statistical analysis only considered SS 1–3 because of the very small number of horses in the fourth category. They were included in the third category. The survival rate was significantly different between the categories of the SS, with a survival rate of 68.8 % for SS 1, 49.1 % for SS 2 and 12.9 % for SS 3 (Fig. 2). The logistic regression model showed a significant odds ratio of dying of 10.8 for SS 3 versus SS 1.

Table 3. Type of pathology and numbers of survivors and non-survivors

	Survivors	Non-survivors	Total
Large intestine strangulating obstruction	16	28	44
Large intestine non-strangulating obstruction	50	7	57
Small intestine strangulating obstruction	40	56	96
Small intestine non-strangulating obstruction	2	1	3
Total	108	92	200

Table 4. Localization of the obstruction for each category of the gravity score

	GS 1	GS 2	GS 3	Total
Large intestine	16	52	33	101
Small intestine	14	45	40	99
Total	30	97	73	200

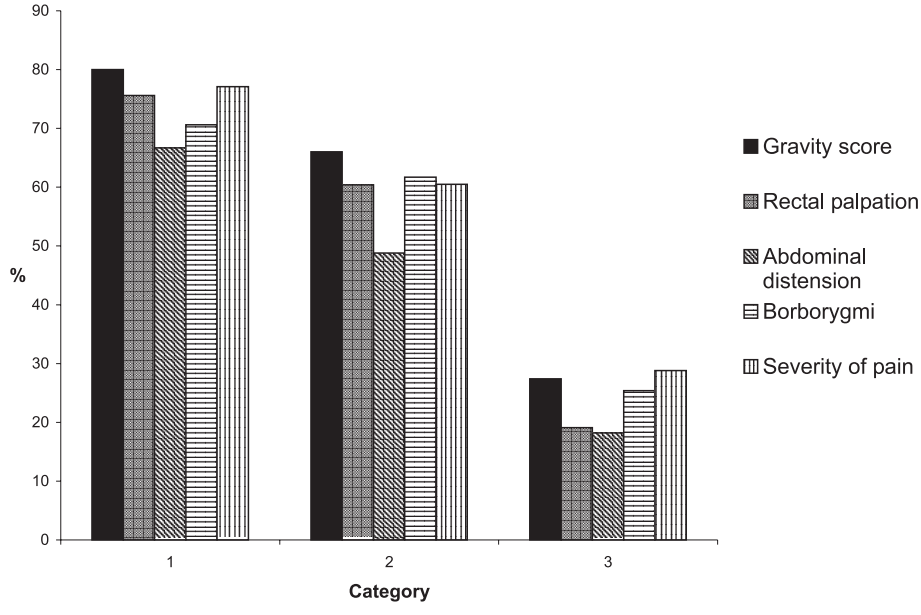

Fig. 1. Survival rate and the three categories of the gravity score and its components.

The mean packed cell volume (± standard deviation) was 39 (± 6) % for surviving horses and 47 (± 8) % for non-surviving horses. The numbers of survivors and non-survivors with their corresponding packed cell volumes are illustrated in Fig. 3. The logistic regression technique showed that the odds of dying increased significantly by 0.5 for an increase of 1 unit of packed cell volume.

The mean heart rate (± standard deviation) was 59 (± 17) for surviving horses and 71 (± 21) for non-survivors. The distribution of heart rate for survivors and non-survivors is shown in Fig. 4. The odds of dying was estimated to be non-significant for heart rate.

The percentage of horses from each category of the SS was significantly different in the categories of the GS as illustrated in Table 5, where you can also see the survival rate of the combined scores which diminishes severely when shock symptoms appear in GS 3.

The logistic regression technique estimated the odds of dying for the GS and SS in the same model, but only GS 3 and SS 3 were considered significant. The odds ratios were 7.1 for GS 3 versus GS 1 and 7.2 for SS 3 versus SS 1.

Discussion

Giving a prognosis for surgical colic remains difficult because of the different variables to consider, such as time elapsed between onset of colic and referral, previous

Table 5. Number and percentage of survivors in the combined gravity and shock scores

	SS 1	SS 2	SS 3
GS 1	22/26 (84.6 %)	2/3 (66.7 %)	0/1 (0 %)
GS 2	39/56 (69.6 %)	23/33 (69.7 %)	3/8 (37.5 %)
GS 3	12/24 (50 %)	7/27 (25.9 %)	0/22 (0 %)

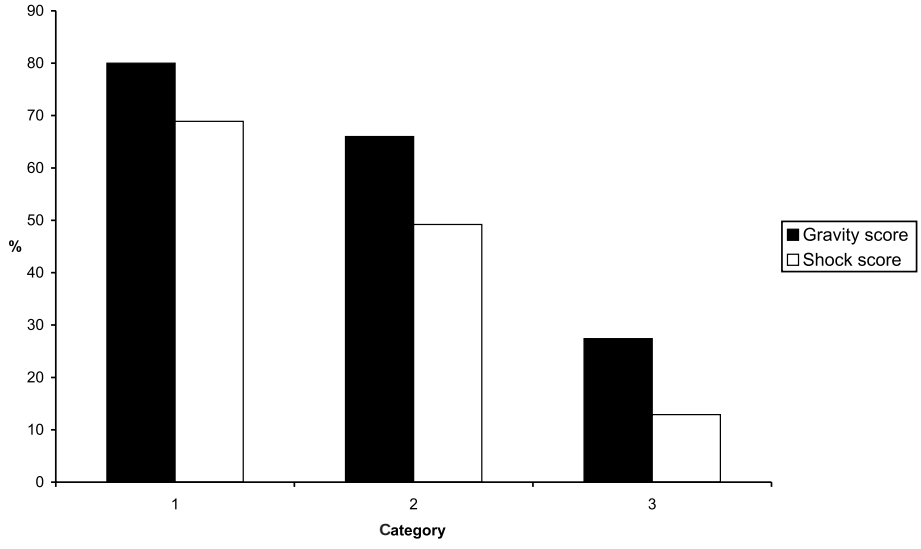

Fig. 2. Survival rate in the different categories of the gravity score and shock score.

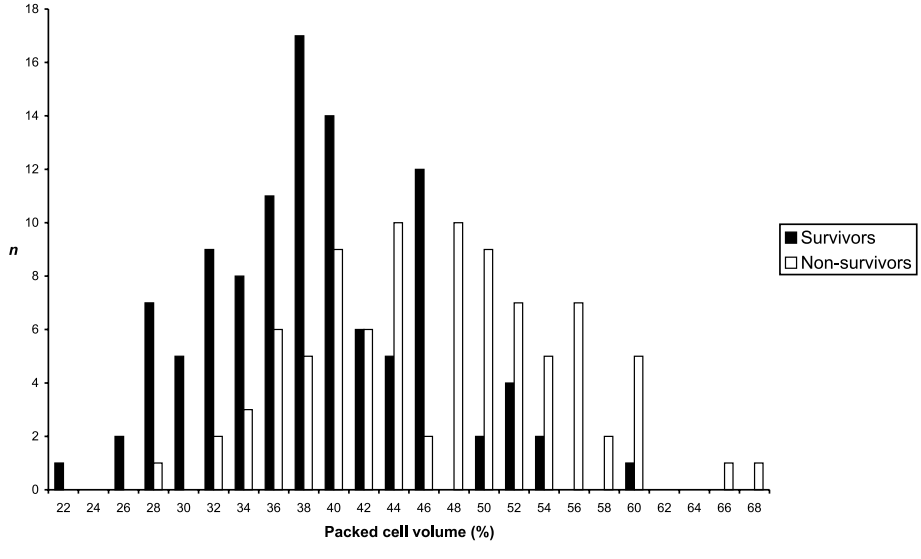

Fig. 3. Distribution of packed cell volume between survivors and non-survivors.

treatments, different nature of the problem (part of bowel concerned and extent of damage) and other individual characteristics.

The results of our study show a similar overall survival rate to other studies (Parry, 1983; Pascoe et al., 1983; Shires et al., 1986).

Survival rate is significantly related to the localization of the pathology because of the high percentage of strangulating obstructions in the small intestine, also observed by other authors (Parry, 1983; McCarthy and Hutchins, 1988; Ebert, 1994a). When only strangulating obstructions are considered, the survival rates (small intestine 41.7 %; large

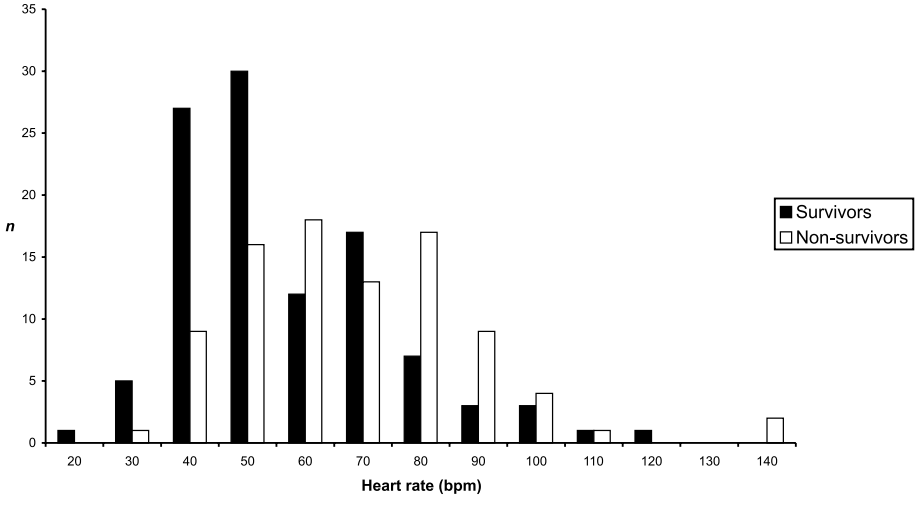

Fig. 4. Distribution of heart rate between survivors and non-survivors.

intestine 36.4 %) are quite similar in our study. These survival rates are quite low, but similar to other studies. Harrison (1988) reported a survival rate of 34.7 % for large intestinal volvulus and Pascoe et al. (1983) reported an overall survival rate of 39.3 % for small intestine lesions.

We found a similar number of cases in the large and small intestine in the different categories of the GS and the number was sufficient for statistical analysis. In spite of a large variety of pathologies, the score can be attributed to every surgical colic case as there was no significant difference between the number of cases in the small and large intestine in the different categories of the GS. Therefore, no separate evaluation of the GS has been performed for the findings of the small or large intestine on rectal examination or during surgery. Other studies could be carried out in order to test the GS on medical colic (large and small colon impaction, large colon meteorismus, anterior enteritis), that could show different results. With a larger number of cases, the GS could be evaluated on the different types of pathologies, as has been partially done in another study (Grulke et al., 2000).

The duration of colic signs is used as a value for prognosis. In a study by Ebert (1994b), longer duration had better prognosis due to the fact that medical and surgical colic cases were evaluated. Another study (Parry et al., 1983a) showed a shorter duration of colic signs for surviving horses, but no significant difference was seen. This could be explained by the fact that very severe strangulation obstructions already led to death with a very short duration after the onset of colic.

Our study shows that the GS has a good prognostic value. We think that the GS is directly related to the survival rate because rectal palpation and abdominal distension estimate the degree of intestinal obstruction. Distension of the bowel is accompanied by higher risks for surgical procedure and anaesthesia, as pointed out by Hackett (1983), and is disturbing the microcirculation of the intestinal wall (Allen et al., 1986; Ebert, 1994a). Particularly strangulation obstructions result in rapid and severe tympany. Furthermore, pain is induced by distension of the bowel and the tension on the mesentery (Allen et al., 1986). Therefore, especially horses with strangulating pathologies with poorer prognosis present severe and continuous signs of pain. Diminished or absent borborygmi could create post-surgical ileus, which still remains a major problem as mentioned in a study by Gerring et al. (1991). Even if all the parameters of the GS are subjective, they become easy

to standardize when classified into three categories. In cases where shock symptoms have not yet occurred because of lasting ischaemia or because of highly effective anti-inflammatory medication, the prognosis can be given when clinical obstructive signs are considered. Furthermore, the clinical obstructive signs are easily observed without the laboratory and the field veterinary surgeon can better estimate prognosis and react more rapidly before the onset of shock symptoms by referral of the horse to a specialized clinic.

Because of the small number of cases with SS 4, SS 3 and SS 4 were combined for the statistical analysis. As already seen in previous studies, shock symptoms are a good prognostic instrument, as with severe shock high mortality is observed. Even if intensive medical therapy significantly controls shock symptoms, they reflect intestinal lesions that may be irreversible or inoperable.

Combining the two scores in the same model diminished the odds ratios and therefore gave only a little more precision. This is due to the fact that the two scores are not independent even if they do not measure the same values.

Isolated parameters of the SS, like packed cell volume and heart rate, were often used for prognosis and also showed significant differences between survivors and non-survivors in the present study. But, especially for heart rate, the distribution was very wide and not linear and, in the logistic regression heart rate, was estimated to be non-significant. This could be explained by the fact that heart rate is influenced by several factors such as pain, excitement (transport, examination at the clinic) causing tachycardia and several drugs like alpha-2 agonists and opioids causing bradycardia. In order to reduce the factors influencing heart rate it should be recorded several times every 10 min after arrival of the horse. The same factors can influence packed cell volume by splenic contraction as already observed in a study by Puotunen-Reinert (1986).

In conclusion, this study shows that the GS based on clinical parameters is a good means to estimate prognosis. Consequently, valuable information could be given to the horse owner by the field veterinary surgeon even without a laboratory. The shock symptoms remain good prognostic parameters, as already shown in other studies. For some cases, prognosis can be more accurately estimated when the two scores are used.

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