

1 **Original Article**

2
3 **Preliminary results on the association with feeding and recovery length in equine colic**
4 **patients after laparotomy**

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22 **Summary**

23 Colic is a serious disease for horses and the nutritional management of post-operative colic
24 patients is an extremely important field. The aim of this retrospective study was to analyse the
25 different factors, especially related to nutritional management, that may be associated with
26 recovery length during hospitalization after a surgical intervention for colic, using a
27 multivariate model. Data were collected from the records of horses presented to two hospitals
28 and undergoing surgery for colic. The length (days) of recovery was the outcome of interest
29 and was taken into account as a reference parameter (short, medium, long). The parameters
30 collected (patient details, preoperative clinical and laboratory examinations, postoperative
31 parameters and post-surgery nutritional parameters) were subjected to multivariate analysis
32 (MCA and PCoA). A ranking class dataset was used to calculate Kendall's tau correlation of
33 the length of recovery with respect to other parameters. Descriptive statistic to identify
34 differences in the recovery length among groups (Kruskall-Wallis and Dunn's Multiple
35 Comparison Test) was also performed. P value was set at <0.05. Groups were not different in

36 preoperative clinical parameters (BCS, PCV, total protein), postoperative parameters (time to
37 1st defecation, time to the end of IV fluid therapy and time to first water drinking, anaesthesia)
38 and patient details (age). The comparison among groups revealed differences on the post-
39 surgical nutritional parameters. Horses with short recovery consumed higher % of DM as
40 forages in the 24 h compared with the horses that have long recovery and reach the minimum
41 DM intake in a shorter period. Both Kendall and MCA analysis confirmed that the time to
42 first feeding had a positive association with the length of recovery. Only 37 horses
43 undergoing colic surgery were included in the study. From a clinical standpoint, this study has
44 shown which nutritional parameters are associated with short recovery.

45

46 Keywords: Colic; Nutrition; Surgery; Management; Multivariate analysis; Welfare
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48

49 **Introduction**

50 The reported prevalence of colic in horses ranges between 4.2 (Traub-Dargatz *et al.*,
51 2001) and 10.6 cases per 100 horse-years (Tinker *et al.*, 1997). Seven to 10% of colic events
52 are fatal in the absence of surgical intervention (Proudman, 1992; Hillyer *et al.*, 2001]. Colic
53 has one of the highest mortality rates (Traub-Dargatz *et al.*, 2001) and, with the exception of
54 musculoskeletal injuries and old age, is the main cause of death in some horse populations
55 (USDA, 2005).

56 Both individual intrinsic and management factors can predispose a horse to colic.
57 Domestic horses are commonly subjected to frequent changes in feed and to diets containing a
58 high level of non-structural carbohydrates and low fibre. In particular, performance horses are
59 often fed starch- and sugar-rich feedstuffs and minimal forage. Such concentrated diets
60 greatly reduce food consumption time, meaning that the horse spends much longer periods
61 without ingesting feed (Clarke *et al.*,1990; Houpt, 1990). In addition, when horses are fed
62 diets other than a high-fibre one, the profile of their microbial population changes, increasing
63 the risk of alterations in the fermentation processes and of metabolic disorders (Julliand *et al.*,
64 2001; Daly *et al.*, 2012; Dougal *et al.*, 2014). Equines appear to have a small “microbial core”
65 in the hindgut (Costa *et al.*,2015) and this may help explain why horses are susceptible to
66 microbial disruption and consequent gastrointestinal disorders (Dougal *et al.*, 2013).

67 According to Mair (2013) few studies have evaluated post operatory feeding practice
68 in order to restore the normal bowel function; even if the number of colic cases undergoing
69 surgery is high, only a small amount of data are available to understand the association
70 between feeding and medical patterns and horse recovery rate during the hospitalization.

71 The aim of this preliminary retrospective study was, therefore, to analyse which
72 factors, especially related to nutritional management, are associated with the recovery of the
73 animal during hospitalization after a surgical intervention for colic. We think that this

74 preliminary data could bring new information in a very important field still not well
75 investigated.

76

77 **Materials and methods**

78 *Patient selection*

79 Data were collected from records of surgical colic cases (performed between the years
80 2012-2017) from the hospitals of the Department of Veterinary Science of the University of
81 Turin (Italy) and of the Department of Veterinary Medicine of the University of Lisbon
82 (Portugal). A total of 37 horses undergoing colic surgery were included in the study and no
83 patient follow-up after hospital discharge was performed.

84

85 *Collection of analysed parameters and codification into classes*

86 The information collected from case records were collected during the recovery period
87 (every four hours) and include: patient details (age, gender, breed) and results of preoperative
88 clinical and laboratory examinations (body condition score, BCS, on a 9 point scale (Henneke
89 *et al.*, 1983); packed cell volume, PCV, in L/L; total proteins, PT, in g/L). The postoperative
90 parameters collected after surgery were:

91 - time (h) to first defecation;

92 - time (h) to the end of IV fluid therapy;

93 - time (h) to first water drinking after the end of IV fluid therapy;

94 - intestinal motility at 8:00 a.m. on the 2nd day after surgery;

95 - intestinal motility at 8:00 a.m. on the 4th day; intestinal motility was assessed through
96 auscultation (according to Sanchez (2010));

97 - Risk Class (RC) categories; abdominal surgeries were classified at the end of surgery as:
98 low, medium, or high risk (Figure 1);

99 - anaesthesia length: duration of the induced anaesthesia in minutes;
100 - post-surgery complications were divided into medical complications (no complications,
101 ileus, site of impaction, no complications, ileus, site of impaction, reflux considered as more
102 than 2 litres of fluids at nasogastric intubation and others) and nutritional complications (no
103 complications, water rejection, food rejection, others);

104 The nutritional parameters assessed after surgery were:

105 - time (h) to the first meal (according to the types of feed consumed) (see Table 1 for a
106 complete description of the feed offered);

107 - % of dry matter (DM) intake as forage (hay and/or grass)/body weight (BW, kg) in the first
108 24 h after surgery, and on the 2nd day after surgery (48-72 h);

109 - % of total DM intake based on all the feed consumed (forages and horse feed)/BW (kg) on
110 the 2nd and the 4th day after surgery (48-72 h and 96-120 h, respectively);

111 - proportion between long fibre (hay) and short fibre (fibrous mix) on the 2nd and the 4th day
112 after surgery;

113 - time (in days) to reach minimum DM intake (in this study it was considered to be 10 g
114 DM/kg BW, according to Geor (2008). Grass intake was also evaluated in the DM
115 calculation, considering that 1 h of grazing approximately corresponded to 0.5 kg of DM (10
116 minutes = 0.083 kg of DM) (Worth, 2010);

117 - recovery (days): was judged according to the possibility of the horse to be dischargeable.
118 That was based on the normalization of all clinical parameters for at least 24 hr, the lack of
119 any behavioural signs indicating pain or inappetence and, the patient ability to eat the whole
120 ration provided. It was conventionally set by the clinician at 8 a.m.

121

122 *Statistical analysis*

123 Statistical analysis was performed using PAST software package (version 2.17)
124 (Hammer *et al.*, 2001). The length (days) of recovery was the outcome of interest for
125 statistical analysis, and was taken into account as a reference parameter. Multiple
126 correspondence analysis (MCA) was used to investigate the correlation between the different
127 parameters and the recovery length.

128 In order to proceed with this combined analysis, all parameters were transformed into
129 a numeric classification using an optimal scaling process. Briefly, classes were balanced on
130 the basis of bibliographic indications, when present, or based on being lower than the 25%
131 quartile or higher than the 75% quartile. Missing data were codified as “?”.

132 A ranking class dataset was clustered according to the length of recovery classes by
133 cosine similarity index (supplementary figure is provided to show cosine similarity index).
134 Subsequently, the ranking class dataset was used to calculate the Kendall’s tau correlation
135 coefficient for the recovery length with respect to other parameters. The correlation
136 significance was then assessed according to Bonferroni corrected multiple comparison p-
137 values.

138 Converted class data were then codified into Dummy variables, i.e., "proxy" variables
139 or numeric stand-ins for qualitative facts in a regression model. The main outcome variable
140 (independent variable), which leads the stratification of the data population, was the length of
141 recovery. From Dummy coded variables, a Burt matrix was generated and used for MCA.
142 Once this procedure had been concluded, PCoA (Principal Coordinates Analysis) was
143 performed directly on the class dataset previously described. The Bray-Curtis dissimilarity
144 matrix was used to ordinate individuals on the plot.

145 Moreover a descriptive statistic was performed with SPSS Statistic 22 to report the
146 patient details, preoperative clinical and laboratory examination results and the postoperative
147 parameters; after checking normality, a statistical analysis to identify differences among

148 classes of recovery length was performed with non-parametric test (Kruskall-Wallis) and
149 Dunn's Multiple Comparison Test (P value was set <0.05).

150

151 **Results**

152 Classes for recovery (short: ≤ 8 days; medium: 9-11 days; and long: ≥ 12 days) were
153 calculated based on the interquartile range and considering the classification made by Sellon
154 and co-workers (2004) in their retrospective study of 31 horses.

155 Thirty-seven cases survived surgery and were therefore included in the study (30
156 surgeries were performed at the Turin Veterinary Teaching Hospital and 7 at the Lisbon
157 Veterinary Teaching Hospital).

158 The frequencies of the patient details data, preoperative clinical and laboratory
159 examination results and the postoperative parameters are shown in Table 2, while in Table 3
160 are reported the median and interquartile range (IQR) of preoperative, postoperative and
161 nutritional parameters divided in 3 classes according to the length of recovery. No differences
162 among classes were recorded for age, BCS, PCV, total protein, anaesthesia time, time to 1st
163 defecation, time to the end of IV fluid therapy and time to first water drinking.

164 DM intake as forage/kg BW in the first 24 hr was higher in the short recovery length
165 class compared to the long recovery class where the median value was 0. The % of DM intake
166 as forage in the 2nd day was higher for short recovery length class as compared with medium
167 (P<0.001) and long (P<0.05). The total DM intake/kg BW in the 2nd day and the 4th day
168 were higher in the short recovery than the long recovery class (P<0.05). Time in days to reach
169 the minimum DM in the short recovery group, 6 (4.5-7.5), was significantly different
170 (P<0.001) than the long recovery group, 12 (12-15). On the other hand, time to reach
171 minimum DM in the medium group, 7.5 (5-11.5), was significantly shorter compared to the
172 long one (P<0.05).

173

174 *Correlation with recovery length*

175 Correlation data are shown in the last column of Figure 2. Recovery length was
176 negatively correlated with BCS classes: a low BCS was more frequent among horses with a
177 longer postsurgical recovery length, whereas a higher BCS was associated with a reduction in
178 recovery length (Kendall's tau = -0.388; $P < 0.002$).

179 A negative correlation was also observed for intestine motility on the 2nd day post
180 surgery (Kendall's tau = -0.490) and for % DM intake as forage/kg BW in the first 24 h and
181 on the 2nd day. Horses that received smaller quantities than 0.1 % DM as forage/BW in the
182 first 24 h and 0.3 % DM as forage/BW on the 2nd day after surgery were more subject to
183 longer recovery (Kendall's tau = -0.365 and -0.445, respectively); in addition, negative
184 correlations were observed for % total DM intake/kg BW on the 2nd and the 4th day after
185 surgery (Kendall's tau = -0.476 and -0.452, respectively).

186 By contrast, significantly positive correlations between recovery length and
187 anaesthesia time (Kendall's tau = 0.367), time to first grass meal (Kendall's tau = 0.425),
188 forage meal (Kendall's tau = 0.421) and time needed to reach minimum DM intake (Kendall's
189 tau = 0.533) were observed.

190

191 *Multivariate analyses*

192 The MCA plot shows a clear gradient along Axis 1 (horizontal axis), which accounts
193 for almost 70% of explained variability, with low score values for short lengths of recovery
194 (variable score < -0.35) and higher scores for longer lengths of recovery (variable score $>$
195 0.6). Accordingly, analysis of the plot reveals the variables that covariate with shorter
196 recovery length and variables that are more recurrent with longer ones.

197 Long recovery was found to be associated with: young age; a BCS between 3 and 4;
198 complications such as reflux or ileus; reduced intestine motility on the 2nd and the 4th day;
199 food rejection; time to grass meal > 24 h; % total DM intake/kg BW on the 2nd day after
200 surgery < 0.35; % total DM intake/kg BW on the 4th day < 0.6; time to reach minimum DM \geq
201 12 days; and use of cereal by-products. Among horse feeds, cereal by-product mix had an
202 adverse association with recovery length. However, a larger number of cases need to be
203 included in this class to confirm this trend.

204 A short recovery length was associated with: a BCS between 6 and 7.5; anaesthesia
205 time < 120 minutes; normal intestine motility on the 2nd day after surgery; duration of IV
206 fluid therapy < 12 h; other nutritional complications; time to 1st grass meal < 12 h; time to 1st
207 preserved forage meal < 12 h; time to 1st compound feed meal < 24 h; % DM as forage/kg
208 BW in the first 24 h > 0.1; % DM as forage/kg BW on the 2nd day after surgery \geq 0.3; % total
209 DM intake/kg BW on the 2nd day after surgery > 0.55; % total DM intake/kg BW on the 4th
210 day after surgery > 0.85; and time to reach minimum DM intake < 11 days.

211 All the other classes were associated with a medium duration of recovery (9-11 days),
212 as gender, haematocrit, total proteins, risk class, time to first defecation and the proportion
213 between long and short fibres did not correlate with a long or short length of recovery.

214 The graphical distribution of individual horses according to PCoA is shown in Figure
215 3. The Bray Curtis algorithm was used to evaluate similarity between individuals. In this
216 analysis, the level of variability explained by the first coordinate, which roughly discriminates
217 between short and long recovery times, was about 24%. The distribution of the single
218 individuals belonging to different classes can, nonetheless, be appreciated: the majority of
219 animals enduring a short recovery are on the right hand side of the graphic, while almost all
220 the horses with a long recovery on the left.

221

222 **Discussion**

223 Comparison among classes of recovery revealed that groups were not different
224 regarding preoperative clinical parameter (BCS, PCV, total protein), postoperative parameter
225 (time to 1st defecation, time to the end of IV fluid therapy and time to first water drinking
226 after) and patient details. Many of them are usually considered as important factors for the
227 recovery of the animals and for this reason a multivariate statistical analyse was used to
228 extrapolate the possible relationships between the recorded variables. Surprisingly, the risk
229 classes adopted in this study did not appear to be directly correlated with the recovery length.
230 On the other hand, shorter anaesthesia duration was associated with shorter recovery length
231 according to MCA scores. Anaesthesia may affect intestinal motility but, when comparing
232 the three classes no differences were identified probably due to the wide interquartile range
233 among each group considered for the comparison.

234 Also no differences were found among age classes. In the present study, old age
235 (maximum patient age being 19 years) did not negatively affect postsurgical length of
236 recovery. Previous studies have associated old age with a lower survival rate (Reeves *et al.*,
237 1989; Proudman *et al.*, 2006), but survival was not included as a parameter in the present
238 study. Other authors did not find any association between age and poorer prognosis (Mair &
239 Smith, 2005; Southwood *et al.*, 2008). On the contrary, this retrospective study identified
240 young age (≤ 5 years) as a negative factor, with higher recovery periods found in younger
241 patients. Gender did not appear to be correlated with the length of recovery but this might be
242 due to the disparity in the number of animals included in the different classes. Our study
243 comprised 24 geldings, 9 mares and just 4 stallions.

244 Body condition score *per se* was not different among classes of recovery. The
245 statistical approach used in the present study however revealed that low BCS was related with
246 longer patient recovery; on the contrary a (moderately) over-weight patient had shorter

247 recovery after abdominal surgery. This could be due to the fact that more fleshy horses have
248 more reserves to mobilize during recovery compared with thin ones.

249 With respect to the clinical parameters, packed cell volume on admission did not seem
250 to be associated with the length of recovery. The collected data show that the time to first
251 defecation did not covariate with the length of the post-surgery period. This may be due to the
252 fact that some surgeries required the emptying of the hindgut while others did not.

253 Reduced intestine motility on the 2nd and the 4th day was associated with a longer
254 post-surgery period, while normal motility on the 2nd day was related to a shorter post-
255 surgery period. However, normal intestinal motility on the 4th day was not clearly correlated
256 with a shorter recovery length, possibly because after 4 days patients reached the same level
257 from a clinical point of view, and motility was no longer significant.

258 For this reason, the condition which is more likely to exert positive influence on
259 recovery length is adequate gut motility in the early phase of the postsurgical period.

260 As far as post-surgery complications are concerned, ileus is associated with a longer
261 recovery length. This is not surprising considering that several studies have identified ileus as
262 one of the main postsurgical complications with high mortality rate (Cohen *et al.*, 2004; Torfs
263 *et al.*, 2009).

264 According to Doherty (2009), in human subjects, the use of traditional IV fluid
265 therapy, when compared with a restricted IV administration of fluid and salts, delays the
266 recovery of the gastrointestinal function. In the present study, brief postsurgical IV fluid
267 therapy was associated with a shorter length of recovery, probably because continuous
268 administration of parenteral fluid does not permit the normal compartmentalization of water
269 in the hindgut, thus altering blood osmolality and affecting the normal desire to drink water
270 and eat. According to Freeman *et al.* (2015) overhydrating unfed horses can be detrimental,
271 and interferes with recovery length.

272 The comparison among classes revealed differences especially on the post-surgical
273 nutritional parameters (Table 3). Horses in the short recovery classes ate higher % DM as
274 forages in the 24 h than the horses that have long recovery and reach the minimum DM intake
275 in a shorter period. Both Kendall and MCA analysis confirmed that the time to first feeding
276 had a positive association with the length of recovery. Horses that were able to eat forages
277 within 12 h after surgery had shorter recovery length. Even if it is likely that horses which
278 recover better from the surgery would start voluntary feeding earlier compared to sick ones,
279 we should also consider that food influences considerably intestinal motility, playing a main
280 role in the reactivation of enterocyte function.

281 The feeds used in the present study were chosen according to the current literature on
282 colic patients (Geor, 2007; Mair, 2013) and included forages (fresh or preserved) and
283 compound feeds (complementary feeds see Table 1).

284 According to our results, the type of feed given is an important factor influencing
285 recovery rate. In fact, our study reveals an association between short recovery length and the
286 provision of forages and fibrous mix within 12 h and 24 h, respectively. However the MCA
287 results showed a negative association between length of recovery and the use of horse
288 compound feed based on cereal by-products. The present study may be limited by the fact that
289 just one product was used and was based on wheat bran.

290 According to our results, there is an association with short recovery length for horses
291 receiving at least 0.1% DM of their BW as forages in the first 24 h post surgery. The
292 corresponding quantity of hay for a 500 kg horse would be equal to 0.5 kg DM. This quantity
293 divided into small meals corresponds to the common feeding regime used in clinical practice
294 that consists of handfuls of hay. Besides, our results show that an association exists when the
295 quantity of forage is increased to at least 0.3 % DM/BW on the 2nd day after surgery. As

296 well, total DM intake higher than 0.55% on the 2nd day after surgery and 0.85 % on the 4th
297 day covariate with a shorter recovery length.

298 Recently Harris and co-workers (2017) suggested that the minimum quantity of DM
299 given as forage should be 12.5 g DM/kg BW, justifying it with health and ethological aspects
300 related to the horse's needs. However, this minimum quantity was intended for a healthy
301 horse, and may not be suitable for a postsurgical recovering patient. In this study, we followed
302 previous indications which considered 10 g DM/kg BW as an adequate amount (Geor, 2008).
303 In fact, the degree of gut-filling is a factor that surgeons are concerned about in their post-
304 operative colic patients, particularly during periods of time in which the drinking stimulus is
305 altered.

306 We are aware that our research may have two limitations. The first is the small
307 number of cases examined, with records from only two hospitals. The second limitation
308 concerns the influence of medical treatments, which was only considered as part of the risk
309 class context and not as a specific parameter. However, this preliminary data can bring new
310 information regarding nutritional management of post-operative colic patients.

311

312 **Conclusions**

313 From a methodological point of view, we show the adaptability of the MCA and
314 PCoA approaches, and of multivariate analysis in general, and their utility for associating
315 multiple variables. From a clinical standpoint, this study has shown which nutritional
316 parameters (% DM intake as forage/BW, % total DM intake/BW and time to reach minimum
317 DM) are associated with a short recovery period. Therefore it is desirable that feed be
318 introduced as soon as clinical parameters start to improve in order to enhance gastrointestinal
319 well-being and, at the same time, restore intestinal microbiome core.

320

321 **Animal Ethics Statement**

322 No permits or ethical committee approvals were required for the described study. The
323 owners of the horses gave written consent for all clinical procedures that are part of routine
324 care and quality standard of the involved hospital.

325

326 **Conflict of interest statement**

327 None of the authors has any financial or personal relationship which could
328 inappropriately influence or bias the content of the paper.

329

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421 **Table 1**

422 Feed type and minimum and maximum values recorded for nutritional composition according

423 to the feed label

FEED TYPE		TYPICAL ANALYSIS (on DM)							Main ingredients
		DM	CP	CFb	Fat	Ash	FL		
Forages	Fresh	Grass	17%	13.3-15%	27.2-28%	2.0-2.5%	9.4-9.7%	> 10 cm	Lolium italicum
	Preserved	Hay	85%	7-8.8%	33-35%	1.2-2%	6.9-7.7%	> 10 cm	First cut meadow hay
		Haylage	50%	11%	43%	3%	6%	> 10 cm	Lolium
Horse compound feed	Complementary feed	Fibrous mix	87%	11-13%	22-24%	5-8%	13%	< 2-8 cm	Hay and alfalfa
		Cereal by-product mix	89%	14.5%	11.5%	11.6%	8.9%	Pellet	Wheat bran

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425 DM: Dry Matter; CP: Crude Protein; CFb: Crude Fibre; Ash: Ashes; FL: Fibre Length

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428 **Table 2**

429 Parameter frequencies for patient details, preoperative clinical and laboratory examinations,

430 and postoperative parameters (n = 37).

Patient details	n	%	Postoperative parameters	n	%
Breed			Surgery risk class		
Sella Italiano	6	16.2	Low (A)	12	32.4
KWPN (Royal Dutch Sport Horse)	5	13.5	Medium (B)	12	32.4
Puro Sangue Lusitano	5	13.5	High (C or D)	13	35.1
Argentine	5	13.5	Medical complications		
Selle Francais	3	8.1	No	22	59.5
Arabian	2	5.4	Reflux	5	13.5
Holstein	2	5.4	Post operative ileus	3	8.1
Others	9	24.3	Small intestine impaction	2	5.4
Age			Others	5	13.5
≤ 5 years	4	10.8	Nutritional complications		
5-15 years	25	67.6	No	21	56.8
≥ 16 years	8	21.6	Water refusing	10	27
Gender			Food refusing	5	13.5
Male	28	75.7	Others	1	2.7
Female	9	24.3			
Preoperative clinical and laboratory examinations					
BCS (from 1 to 9)					
≤ 4	8	21.6			
4-6	17	46			
≥ 6	12	32.4			
Haematocrit (L/L)					
< 0.35	11	29.7			
0.35-0.39	11	29.7			
> 0.40	12	32.4			
Missing data	3	8.1			
Total serum protein (g/L)					
< 60.0	6	16.2			
60.0-69.0	13	35.1			
> 69.0	12	32.4			
Missing data	6	16.2			

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434 **Table 3**

435 Median and interquartile range of the preoperative, postoperative and nutritional parameters
 436 in the analyzed cases (n = 37). Values with symbols identify differences <0.001 while values
 437 with letters identify differences <0.05 according to Dunn's multiple comparison test

	Length of recovery (in days)		
	Short (<8)	Medium (9-11)	Long (>12)
Age (years)	12 (10.5-14)	10 (5-15)	12.5 (11-17)
BCS (from 1 to 9)	5.75 (4.5-6)	5 (4.5-6)	4 (4-5)
PCV (L/L)	0.375 (0.35-0.41)	0.38 (0.33-0.41)	0.37 (0.33-0.39)
Total Protein (g/L)	69.0 (64.0-74.5)	64.0 (59.0-73.5)	60.0 (47.0-74.0)
Time (min) for anaesthesia	120 (112.5-135)	142.5 (127.5-162.5)	160 (120-185)
Time (h) to 1st defecation	15.5 (7.5-23.5)	11.5 (8-28)	14 (12-24)
End of fluid therapy (h)	0 (0-24)	27.5 (0-42)	113
Time (h) to 1st water drinking after end of fluid therapy	24 (6-39)	19.5 (6-52.5)	4
% DM as forage/BW in the first 24 h	0.090 ^a (0-0.225)	0 ^{ab} (0-0.16)	0 ^b (0-0)
% DM as forage/BW in the 2nd day	0.415 ^{δa} (0.295-0.545)	0.190 ^Ω (0.070-0.360)	0.110 ^b (0-0.180)
% total DM intake/BW in the 2nd day	0.635 ^a (0.495-0.815)	0.420 ^{ab} (0.165-0.600)	0.420 ^b (0-0.440)
% total DM intake/BW in the 4th day	0.890 ^a (0.770-1.215)	0.535 ^{ab} (0.235-1.065)	0.430 ^b (0-0.740)
Time to reach minimum DM (days)	6 ^{ad} (4.5-7.5)	7.5 ^a (5-11.5)	12 ^{bΩ} (12-15)

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443 **Figure legends**

444 Fig. 1 Risk class categories and related lesions (Valle *et al.*, 2016)

445

446 Fig. 2 Numeric classification by scaling process for the class division, Kendall's tau
447 correlation coefficient to length of recovery and classification according to MCA scores

448 Notes: Time is expressed in hours. Classes were balanced on the basis of bibliographic
449 indications (BCS according to Hennecke *et al.* (1983); Hematocrit according to Proudman *et*
450 *al.*, (2006); Total Proteins according to Mair & Smith (2005); Type of surgery according to
451 Valle *et al.* (2016)), when present, or based on lower 25% or higher 75% quartiles. Arrows
452 were assigned based on MCA score: variable score < -0.35 associated with short recovery
453 have ↓; variable score > 0.6 associated for long recovery have ↑; Classes with no arrows are
454 associated with medium recovery length (9-11 days).

455

456 Fig. 3 PCoA analysis with Bray-Curtis dissimilarity coefficient to evaluate similarity between
457 individuals (red dots: ≥ 12 days; yellow dots: 9-11 days; green dots: ≤ 8 days)

458

459 Supplementary Information Items

460 Fig. 4 (supplementary). Clustering of analyses in recovering horses according to Cosine
461 similarity (red: ≥ 12 days; black: 9-11 days; green: ≤ 8 days)

462