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COLIC IN THE BRITISH MILITARY WORKING HORSE POPULATION – A RETROSPECTIVE ANALYSIS

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ABSTRACT

Colic is a common and potentially life-threatening condition of horses. Multiple risk factors have been previously identified and it is known that a careful management routine can help to reduce colic rates. The British military working horse population represents a unique cohort of horses that are intensively managed with a strict regimen. This retrospective study examined the incidence and mortality rate of colic within this population, as well as the signalment of affected horses, and compared these with the general population. Data for 717 horses over a five-year period (2008-2012) were analysed. Of these, 163 horses (22.7%) experienced 267 colic episodes and thirteen horses (1.8%) died because of colic. Recurrent colic was experienced by 35% (57/163) of horses. The incidence of colic was 11.1 episodes per 100 horse years and of colic-related death was 0.5 deaths per 100 horse years. Horses purchased from mainland Europe were more likely to suffer from colic (OR4.6; \( P<0.001 \)) and from recurrent colic (OR6.0; \( P=0.005 \)) than horses purchased from Ireland. Only 3% (8/267) of colic episodes were treated surgically. It was concluded that the incidences of colic and colic-related deaths within the British military working horse population are similar to those of the general horse population.
INTRODUCTION

Colic is an extensively described clinical syndrome in horses – numerous epidemiological studies have described the age, sex and breed of horses suffering from colic, as well as the incidence and mortality rate.\(^1\)\(^-\)\(^8\) Further studies have evaluated the risk factors for colic including housing, feeding, exercise and veterinary factors.\(^3\)\(^-\)\(^4\)\(^,\)\(^7\)\(^-\)\(^9\)\(^-\)\(^14\)

There are few studies investigating veterinary problems amongst military working horses. Putnam et al\(^15\) recently described lameness within one subset of the British population while Laranjeira et al\(^16\) detailed colic within a Brazilian population.

The British military working horse population represents a unique cohort of horses that are intensively managed with strict regimens. They are divided into three distinct populations – the Defence Animal Centre (DAC), the Household Cavalry Mounted Regiment (HCMR), and the King’s Troop Royal Horse Artillery (KTRHA). Horses are routinely stabled or stalled, undertake a minimum of an hour of exercise on six days per week, and have a period of pasture rest for several weeks at least once yearly. Roughage (hay or haylage) and concentrate feeding (generally chaff and fibre nuts) are tailored to each individual horse’s needs based on their exercise intensity and body condition. All horses have access to fresh water from an automatic drinker or bucket when stabled or stalled, and from a water trough when grazing. Stabling consists of a loose box where the horse may move around freely. Stalling consists of an area where the horse is tethered by a headcollar and retractable rope such that it may reach the floor to eat or drink, may lie down or may reach round to groom itself, but it may not turn around completely within the stall. They are routinely vaccinated against equine influenza and tetanus, and regularly de-wormed following a military-wide, rotational, synchronized anthelmintic schedule. Dental examinations and treatment are conducted annually by a veterinary surgeon or registered equine dental technician; those horses that require more frequent treatment are afforded this as necessary. Veterinary care at each site is provided by a dedicated veterinary surgeon and veterinary technician. All personnel involved in horse care are given regular instruction regarding the signs of colic and the immediate action to be taken for cases of suspected colic.
There are several features of the British military horse’s regimen that may contribute to an increased risk of colic; for example, stalling and reduced access to pasture, exercising more than once per week and having more than one care-giver. There are also some features of their management that could contribute to a reduced colic rate; for instance, regular anthelmintic treatment and careful dietary changes.

The aims of this retrospective cohort study were to describe the incidence and mortality rate of colic within the British military working horse population, as well as the signalment of those horses suffering from colic, and to compare these outcomes to the general horse population.
MATERIALS AND METHODS

Ethical approval for the retrospective collation of data from clinical records was obtained from the Royal Veterinary College’s Social Science Research Ethical Review Board. Permission to collate and analyse the data was obtained from the Director Army Veterinary and Remount Services prior to the start of the study. Data from the clinical records of horses that undertook military work at any time between 1st January 2008 and 31st December 2012 were recorded. Records of those horses that remained in military work were accessed from the veterinary clinics of the three populations. Records of horses that concluded their military work (either through retirement, euthanasia or death) during the study period were accessed from archived records.

Details of the horses’ year of birth, sex, breed, country of purchase and population subset were recorded. Country of purchase was categorised as: ‘Ireland’, meaning Northern Ireland and Republic of Ireland; ‘GB’ (Great Britain), meaning England, Scotland and Wales; and ‘Europe’, meaning mainland Europe. Population subset was categorised as: ‘DAC’ (Defence Animal Centre), ‘HCMR’ (Household Cavalry Mounted Regiment), or ‘KTRHA’ (King’s Troop Royal Horse Artillery). Each horse’s total time at risk during the study period (months) was calculated from its date of entry into and date of exit from military work; for ease of calculation, one month was counted for each whole month or part thereof that the horse was in military work. The number of colic episodes suffered by the horse during the study period, and if the horse died or was euthanased because of colic, were recorded. A horse was deemed to have suffered from a colic episode if either: a) an event of ‘colic’ was recorded by the attending veterinary team, or b) clinical signs of colic including, but not limited to, rolling, pawing, flank watching, kicking the abdomen or prolonged recumbency, with or without reduced faecal output or reduced appetite, were recorded by the attending veterinary team. A colic episode was deemed to have resolved when either: a) the veterinary team recorded that the horse had ‘returned to normal’ or was ‘discharged’, or words to that effect, or b) when ≥48 hours had passed before the next entry was made in the clinical record. For each colic episode, the month and year of the episode, as well as the age of the horse at the time of the episode, and the treatment received (medical or surgical), were recorded. Age (in years) was calculated on the assumption that each horse was born on January 1st of its birth year, and the month of the colic episode was counted...
as a whole month regardless of the day the colic episode occurred. Horses were deemed to have died of colic when the clinical signs of colic directly preceded death. Horses were deemed to have been euthanased due to colic when the veterinary surgeon’s decision to euthanase the horse was directly related to the colic episode.

Colic episodes were defined as being recurrent if ≥48 hours passed between colic episodes, during which time no further abnormalities that may be associated with colic were recorded. The time at risk (months) for horses with recurrent colic was calculated from the date of the first episode of colic until the date of exit from military work.

Data were analysed using Stata® version 13 (StataCorp LP, College Station, Texas, USA). Categorical variables (sex, country of purchase, population subset, month, year, treatment) were summarised using number and percentage. Incidence rates were calculated by dividing the number of episodes or deaths by the total time at risk (years) and multiplying by 100. Relationships between sex, country of purchase and population subset of horses suffering from colic and recurrent colic were examined using cross-tabulations and tested for significance using a univariable logistic regression model. Variables with a univariable P-value of ≤0.1 were taken forward to multivariable analysis. Models were built using a manual forward step-wise approach, with a likelihood ratio test value of P<0.05 used as the threshold for retention. Outliers were checked for data entry errors and retained in the model. It was considered that there were no biologically plausible interactions. The final fit of the final model was tested using the Hosmer-Lemeshow goodness-of-fit test. Exact (Clopper Pearson) 95% confidence internals were calculated around morbidity and mortality estimates. Continuous variables (time at risk, total colic episodes, age) were tested for normality using the Shapiro-Wilk test and were not found to follow a normal distribution. These were summarised using median, minimum and maximum values. Significance was set at P<0.05.
RESULTS

A total of 766 horses were identified as being in military work during the study period however 49 clinical records, representing 6.4% of the eligible horses, were inaccessible and so were excluded from the study. Of the 717 horses that were included, 505 (70.4%) were geldings, 211 (29.4%) were mares and one (0.1%) was a colt. A total of 35 different horse breeds were recorded and 493 (68.8%) horses had no breed listed. The three most common horse breeds were Irish Sport Horse and associated cross-breeds (n=115; 16.0%), Irish Draught and associated cross-breeds (n=34; 4.7%) and KWPN (n=12; 1.7%). The majority of horses (n=511; 71.3%) were purchased from Ireland, 181 (25.2%) were from GB and 25 (3.5%) were from elsewhere in mainland Europe. Just over half (n=378; 52.7%) of horses were from the HCMR, 176 (24.5%) were from the KTRHA and 163 (22.7%) were from the DAC. The total time at risk was 28,750 months (2395.8 years; range 1-60) and 266 (37.1%) horses were at risk for the entire study period (60 months).

A total of 163 (22.7%; 95%CI 19.7-26.0) horses suffered colic during the study period and there were 267 colic episodes in total. The majority of horses (n=106; 65.0%) that suffered colic only had one episode during the study period. The maximum number of episodes suffered by any horse was thirteen (Figure 1). The incidence of colic was 11.1 episodes per 100 horse years. The median age of horses experiencing a colic episode during the study period was 9.8 years (range 3.7-23.8). The number of colic episodes per month and per year are shown in Figure 2. Most colic episodes (n=259; 97.0%) were treated by medical means while eight (3.0%) cases underwent surgical treatment. Univariable and multivariable relationships between recorded variables and occurrence of colic are summarised in Table 1.

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Table 1 – Univariable and multivariable associations with occurrence of colic in a population of British military working horses (n=717).
Fifty-seven horses (35%; 95%CI 27.7-42.8) suffered from recurrent colic and they experienced 104 episodes of colic. The total time at risk was 1901 months (238.5 years; range 2-60). The incidence of recurrent colic was 65.7 episodes per 100 horse years. The median age of horses experiencing a recurrent colic episode during the study period was 8.8 years (range 5.8-21.4). The number of recurrent colic episodes per month and per year are shown in Figure 3. Most recurrent colic episodes (n=100; 96.2%) were treated medically however four (3.8%) cases underwent surgical treatment.

Univariable and multivariable relationships between recorded variables and occurrence of recurrent colic are summarised in Table 2.

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</tr>
<tr>
<td></td>
<td>DAC</td>
<td>18 60.0</td>
<td>12 40.0</td>
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</table>

Table 2 – Univariable and multivariable associations with occurrence of recurrent colic in a population of British military working horses suffering from colic (n=163).

OR = odds ratio. CI = confidence interval. Ref = reference variable.

Thirteen horses died or were euthanased due to colic during the study period giving an overall mortality rate of 1.8% (95%CI 1.0-3.1) in the entire study population (n=717) and an incidence of 0.5 deaths per 100 horse years. Amongst those horses experiencing a colic episode (n=163), the mortality rate was 8.0% (95%CI 4.3-13.2). Nine horses (69.2%) were geldings and four (30.8%) were female. The majority (n=11; 84.6%) were purchased from Ireland with only one (7.7%) from GB and one (7.7%) from the rest of mainland Europe. Most (n=11; 84.6%) were from the HCMR with only one horse (7.7%) from each of the KTRHA and DAC. The median age of horses dying from colic during the study period was 12.5 years (range 5.7-21.8).
Seven horses with recurrent colic died or were euthanased during the study period giving an overall mortality rate of 1.0% (95%CI 0.4-2.0) in the entire study population (n=717). Amongst those horses experiencing recurrent colic episodes (n=57), the mortality rate was 12.3% (95%CI 5.1-23.7) and the incidence was 4.4 deaths per 100 horse years. There were four female horses (57.1%) and three geldings (42.9%). The majority of horses (n=6; 85.7%) were from Ireland with only one (14.3%) from GB. Most (n=6; 85.7%) were from the HCMR with only one (14.3%) from the KTRHA. The median age of horses dying from recurrent colic during the study period was 14.2 years (range 8.1-17.8).

Seven out of eight horses (87.5%; 95%CI 47.3-99.7) that underwent surgery at an equine referral hospital were euthanased, including all four horses undergoing surgical treatment for recurrent colic. In three cases a large colon abnormality was identified but the colon ruptured during surgery. One further horse was euthanased on the operating table with a diagnosis of septic peritonitis. The remaining three horses survived surgery but were subsequently euthanased due to post-operative colic or ileus. Due to the small numbers of horses that died or were euthanased, further statistical analyses were not conducted.
DISCUSSION

The results of this retrospective cohort study have defined the signalment, incidence and mortality rate of colic within the British military working horse population.

The incidence of colic in this study population was 11.1 episodes per 100 horse years. Published incidence rates of the general horse population in temperate climates vary from 3.5-26.0 cases per 100 horse years.\(^2\)\(^{-}\)\(^3\)\(^6\)\(^{-}\)\(^8\)\(^14\) This population is therefore within the mid-range of previously established figures. Hillyer \textit{et al}\(^2\) recognised that the true incidence of colic is likely to be underestimated by practice-based surveys. The current figure is therefore likely to be closer to a true incidence than other studies because every episode of colic in this population is reported to the veterinary team and recorded in the clinical record, regardless of the severity of the colic episode or the treatment undertaken.

Only two previous studies estimate the overall mortality rate of colic in the general population: Kaneene \textit{et al}\(^17\) found that 0.6\% (10/1818; 95\%CI 0.3-1.0) of horses died from colic, while Higuchi’s\(^18\) study reported an estimate of 2.0\% (306/15,208; 95\%CI 1.8-2.2). In this study population the result was 1.8\% with a 95\% confidence interval of 1.0-3.1\%. Published estimates of the mortality rate amongst horses suffering from colic\(^2\)\(^{-}\)\(^3\)\(^6\)\(^{-}\)\(^7\)\(^17\)\(^19\) (excluding studies examining referral equine populations) range from 6.3\% (32/509; 95\%CI 4.3-8.8)\(^2\) to 13.0\% (10/77; 95\%CI 6.4–22.6),\(^3\) which is again comparable with our estimate of 8.0\% (95\%CI 4.3-13.2). Finally, in our study the incidence of mortality was 0.5 cases per 100 horse years, which is comparable with published values of between 0.24 and 0.7 cases per 100 horse years.\(^1\)\(^{-}\)\(^3\)\(^6\) We therefore concluded that the occurrence of colic-related deaths in British military working horse population does not differ significantly from that of the general population.

In our study, sex was not associated with the likelihood of suffering a colic episode. There is a single study in which geldings were found to have a reduced risk of colic\(^3\) and another that found geldings have an increased risk of colic,\(^20\) but the current findings fit with the majority of studies which state that the risk of colic does not vary by sex.\(^1\)\(^{-}\)\(^4\)\(^7\)\(^9\)\(^12\)\(^19\)\(^21\)\(^22\)
Given that the majority of horses had no specific breed listed in their documentation, the country of purchase was investigated as an alternative parameter which may give some indication of breed-associated relationships. Horses purchased from mainland Europe had a higher rate of colic than those from Ireland or GB. Most of the military working horses that originate from mainland Europe may be classified as warm blood types as opposed to the Irish and GB horses which would generally be classed as cold blood types. These results are therefore in accordance with previous studies identifying higher rates of colic in Warmbloods and Thoroughbreds than in cold blood breeds.\textsuperscript{1,11}

Although all British military working horses are managed in a highly structured manner, there are some substantial differences between the three populations, depending on their role. For instance, the horses at the DAC are more likely to undertake schooling work and are all stabled whereas the HCMR horses primarily undertake road work and are mainly stalled. The lower occurrence of colic in the DAC than in HCMR horses observed in this study may be explained by DAC horses having more ready access to pasture\textsuperscript{11} and more regulated care-giving\textsuperscript{2,5} compared with the HCMR horses.

Previously reported median/mean ages of horses experiencing colic episodes range from 4.8 to 10.3 years.\textsuperscript{1,3,5,12,20-21} Some studies report an increased risk of colic with increasing age\textsuperscript{1,5,18} whilst others report no association.\textsuperscript{19,21} The median age of 9.8 years in our study population was therefore at the higher end of the range of other studies. British military working horses are typically selected for purchase at around five years of age and consequently there were only a small number of younger horses in the current study population. We also found that the median age of horses dying from colic (12.5 years) was greater than for horses experiencing colic in general; it is also often stated that the risk of colic-related mortality increases with age.\textsuperscript{1,3,5,18}

There are variable reports of the seasonality of colic although most reports find an increase in the spring.\textsuperscript{2,6-7,18-19} The highest number of colic episodes during this study were in November and June/July. These months coincide with the tail-end of the busiest periods of ceremonial activities, with multiple parade rehearsals and disruption to the horses’ daily routine in the weeks running up
to these times, followed by a complete change in routine as the horses are moved to grass turnout for a number of weeks over the summer or winter. Conversely, December and January are a quiet time in the ceremonial calendar for the horses; their regimen is more strictly adhered to and more horses are at pasture thereby resulting in fewer colic episodes at this time of year. Although we did not analyse the occurrence of colic across years, Egenvall et al\textsuperscript{1} found no pattern of colic incidence across the six years of their study.

Only 3% of the study population were referred for surgery at an equine referral hospital which is comparable to published estimates ranging from 1.4 to 17.0\%.\textsuperscript{2-3,7} Reported estimates of mortality\textsuperscript{3,5,20-22} of horses undergoing colic surgery range from 30.8\% (4/13; 95\%CI 9.1-61.4)\textsuperscript{3} to 58.0\% (195/336; 95\%CI 52.6-63.4)\textsuperscript{22} with a grave prognosis (between 97.3\textsuperscript{22} and 100\%\textsuperscript{5} mortality) for horses whose viscera rupture during surgical manipulation. The surgery mortality rate in our study population was high (87.5\%; 95\%CI 47.3-99.7), probably because the management of colic cases within barracks went beyond what would be expected of a normal primary care veterinary surgeon and horses were only referred for surgery when their condition deteriorated, by which time the overall prognosis for survival had already reduced. However, because of the very small numbers of horses that underwent surgery in our study population the confidence intervals are very wide, and they do overlap with published estimates of surgical mortality rates.

Multiple studies briefly document the number of horses experiencing more than one colic episode during their study period,\textsuperscript{2,3,6,13,19} however few studies specifically examine recurrent colic.\textsuperscript{23-25} The definition of recurrent colic differs between these studies; most recently Scantlebury \textit{et al} (2011) defined it as a subsequent episode of colic that occurred "on the proviso that the horse had been free from colic signs, eating a normal diet and passing normal faeces for a full 48 hours since the end of the previous colic episode". Due to the variety of detail contained within the clinical records of this population, it was not always explicitly stated that an episode of colic had resolved. We therefore defined an episode of colic as being recurrent if at least 48 hours passed between colic episodes, during which time the clinical record recorded no further abnormalities that may be associated with colic and we took this to mean that the horse had returned to normal feeding and
faecal output. Based on this assumption, we found that 35% of horses (95%CI 27.7-42.8) suffering from colic experienced recurrent colic episodes and that the incidence of recurrent colic was 65.7 recurrent episodes per 100 horse years. Reported estimates of recurrent colic vary from 3.9% (7/179; 95%CI 1.6-7.9)\(^\text{19}\) to 53.4% (102/191; 95%CI 46.1-60.6)\(^\text{13}\) with the most recent study\(^\text{24}\) documenting an estimate of 36.5% (38/104; 95%CI 27.3-46.5) and an incidence of 50 episodes per 100 horse years which is broadly similar to our findings. Scantlebury et al’s study\(^\text{24}\) also recorded a recurrent colic mortality rate of 10.5% (4/38; 95%CI 2.9-24.8) and an incidence of death from recurrent colic of 3.37 deaths per 100 horse years. These findings are also similar to our own which were 12.3% (95%CI 5.1-23.7) and 4.4 deaths per 100 horse years respectively.

We found that female horses were more likely to suffer from recurrent colic than male horses; this is in contrast to Scantlebury’s study\(^\text{25}\) which found no relationship with sex. Signs of colic are not always linked to gastrointestinal pain and female horses may experience colic episodes attributable to reproductive tract pain, either in relation to seasonal behaviour or reproductive tract abnormalities.

As we found with all colic episodes, horses from Europe were more likely to suffer from recurrent colic than horses purchased from Ireland. A previous report found no association with breed\(^\text{25}\) however this may again be explained by the country of purchase relating to breed type, as previously discussed.

The median age of horses suffering from recurrent colic episodes in our population was 8.8 years which is slightly younger than previously reported (11 years)\(^\text{24}\) however no association of age with occurrence of recurrent colic has been documented.\(^\text{25}\) The median age of horses dying from recurrent colic in this study was 14.2 years however there are no previously recorded findings to compare this figure to.

The highest number of recurrent colic episodes occurred in November, which was also the peak time for all colic episodes. The least recurrent colic episodes occurred in January and June; January was also a quiet time for colic in the whole population however June and July were the second busiest
months for colic. Season is not discussed in any of the publications regarding recurrent colic so it is difficult to draw any worthwhile conclusions. The highest number of recurrent colic episodes occurred in 2011 and 2012 which is also similar to the occurrences of all colic episodes, however there was a much lower number of recurrent colic episodes in 2008, in contrast to the number of colic episodes overall. This may represent either an increase in the number of horses experiencing recurrent colic or increased identification of subtle colic signs in horses that were prone to recurrent colic episodes.

Four (3.8%) episodes of recurrent colic were treated surgically in comparison to Scantlebury et al’s study in which 12.5% underwent surgery. Our estimate may represent more horses experiencing low grade, mild colic that did not require surgical treatment. Cases of colic may also have been recognised sooner, especially in horses that were known to be prone to colic, enabling prompt effective treatment before the case required surgical intervention.

In any study describing a disease process, the results obtained are dependent on the specific study design and population. This is accentuated when considering equine colic studies where data may be gathered from owners, primary care vets, referral hospitals or insurance statistics, and the study population ranges across many different countries and specific horse groups. Although this study has detailed yet another cohort of horses, the intensive nature of their day-to-day management is not dissimilar to other strict horse management regimens (e.g. police horses, racehorses) therefore these results may be applicable to such populations.

Despite their intensive management, British military working horses do not seem to experience a higher rate of colic or colic-related death than the general equine population. We did not attempt to establish specific risk factors in this population due to the variety of detail recorded in the clinical records and due to non-availability of details regarding factors such as daily exercise, pasture turnout and stereotypical behaviours. However, some previously identified risk factors are pertinent in this population, for example stalling and reduced access to pasture, exercising more than once per week and having more than one care-giver. Equally, some features of the management of these
horses are likely to contribute to a reduced colic rate, for instance regular anthelmintic treatment and careful dietary changes.\textsuperscript{10-11} Risk factors for recurrent colic include stereotypical behaviours (crib-bitings,\textsuperscript{24-25} windsucking\textsuperscript{24-25} and weaving\textsuperscript{25}) as well as known dental abnormalities,\textsuperscript{24} and increased time at pasture is associated with a reduced risk.\textsuperscript{25} It is not possible to comment on the association of stereotypical behaviour on the risk of recurrent colic in this population as the clinical records do not note such behaviours. Further studies would be required to identify and quantify the risk factors within this unique population including, but not limited to: dietary management, stereotypical behaviours, access to pasture and daily exercise regimen/ceremonial parade schedule.

The biggest limitation of this study was the retrospective analysis of data. Further description of each colic episode to determine investigatory procedures, diagnosis, treatment given, and potential risk factors was not possible due to a lack of specific clinical notes relating to these parameters in many cases. The limited nature of this population is also recognised with only small numbers of young (<5 years old) and geriatric (>20 years old) horses, and of entire male horses.

This retrospective cohort study concludes that, despite their intensive management regimen, the occurrence of both colic and colic-related deaths within the British military working horse population are similar to those of the general horse population.
COMPETING INTERESTS

V.J. Tannahill is a serving Reserve Veterinary Officer in the Royal Army Veterinary Corps. J.M. Cardwell and T.H. Witte have no competing interests to declare.

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AUTHORSHIP

V.J. Tannahill contributed to all aspects of the study. J.M. Cardwell contributed to analysis and interpretation of data, manuscript preparation, and final approval. T.H. Witte contributed to study design, manuscript preparation and final approval.
REFERENCES


**FIGURE LEGENDS**

**Figure 1** – Number of colic episodes for each horse experiencing colic.

**Figure 2** – Number of colic episodes per month and per year.
Figure 3 – Number of recurrent colic episodes per month and per year.