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A Retrospective Study on Common Health Problems in Ruminants

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Abstract | The reason for performing post-mortem examination is to uncover the possible cause(s) of death in animals. Retrospective study based on post-mortem records was previously highlighted as useful for general surveillance of animal health conditions and diseases. This article describes a retrospective study involving carcasses of ruminants that were presented to the Post-Mortem Laboratory, Faculty of Veterinary Medicine, Universiti Putra Malaysia. Twelve-year post-mortem records of ruminant cases between January 2006 and December 2017 were gathered. A total of 802 ruminant cases were analyzed, comprising of 491 goat, 118 cattle, 95 cervine, 75 sheep, and 23 gaur cases. Failure of the circulatory system (32.6%) was recorded to be the most significant ($p<0.05$) body system affected, followed by the respiratory (23.2%) and alimentary systems (15.1%). Septicaemia (63.8%, n=229), bacterial pneumonia (51.2%, n=203), and gastrointestinal parasitism (51.2%, n=136) were significantly ($p<0.05$) the most frequently reported cases for the respective systems. Pulmonary congestion and oedema were the histopathological lesions most frequently reported in cases of septicaemia. In cases of bacterial pneumonia, bacterial colonies and inflammatory cells were commonly observed. Parasites were often observed microscopically following gastrointestinal parasitism. The significance of the findings was further discussed. *E. coli*, *Pasteurella* spp., and *K. pneumoniae* were important species/genus contributing to septicaemia and/or bacterial pneumonia in ruminants. Data collected from this study would be a valuable resource for the formulation of more effective preventive measures or strategies against these commonly reported diseases. The results presented in this study are valuable in formulating preventive strategies against these common health problems.

Keywords | Retrospective study, Post-mortem, Ruminants, Health problems

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INTRODUCTION

Ruminants are herbivores that are largely populated by domesticated cattle, goats, and sheep. They are beneficial mammals to humans as they are able to acquire energy from low nutrient density plant-based feed and turn it into food for humans. Furthermore, ruminants are important in the agriculture sector, providing animal protein for human consumption as part of food security for a particular nation (Sansoucy, 1995). Ruminant production in the Southeast Asian countries, however, is still unable to meeting the local demand (Devendra, 2007) due to various reasons, including health problems. A previous study in Peninsular Malaysia revealed that the most common disease among small and large ruminants is associated with infection by *Pasteurella* spp. (Saharee and Fatimah, 1993). Other diseases appeared in Malaysia through importation of livestock hence, studies of ruminant diseases in Malaysia were oriented towards diseases caused by specific microorganism such as brucellosis, pasteurellosis including haemorrhagic septicaemia and shipping fever, mannheimiosis, caseous lymphadenitis, mastitis, and parasitic gastroenteritis (Anka et al., 2014; Othman et al., 2014; Zamri-Saad and Annas, 2016; Fitri et al., 2017; Sadiq et al., 2019).

One of the methods for surveillance of animal health is to gather and analyze information from post-mortem reports (Küker et al., 2018) since this procedure is able to provide diagnosis and the cause(s) of death. Retrospective analysis of post-mortem reports has been previously used to ana-

lyze septicaemic diseases in companion animals, proving its superiority in detailing out the relationship between risk factors, age of animals, and species of bacteria (Rathiymaler et al., 2019). This article aimed at highlighting the common health problems based on retrospective analysis of pathological examinations among ruminants presented to the Post-Mortem Laboratory, Faculty of Veterinary Medicine, Universiti Putra Malaysia.

MATERIALS AND METHODS

Data Collection

Post-mortem record of ruminant cases between 1st January 2006 and 31st December 2017 were selected. Only those cases with a confirmatory diagnosis were included in this study. Cases without definitive diagnosis and cases involving ruminant species that were presented less than twice a year were excluded. Information of each case, including species, laboratory results, and final diagnosis were analyzed. The diagnoses were categorized based on the affected body systems; the circulatory, respiratory, alimentary, metabolic, musculoskeletal, hepatobiliary, excretory, reproductive and integumentary systems. An additional category, known as 'Others' was included for diagnoses that could not be categorized into any of the mentioned body systems.

Data Analysis

The data were analyzed using Statistical Packages for the Social Sciences (SPSS) version 24. Non-parametric test was used for data analysis at 95% confidence interval level. Subsequently, Pearson's chi-square test was used to determine the occurrence rate of all diseases and to identify significance of prevalence between the three most common diseases compared to the rest of the diseases. Data on classification of body systems to different animal species was analyzed using risk analysis technique.

Gross and Histopathology Changes

Following analysis of records, the three most common health conditions were identified. Ten representative cases for each of the three common diseases were randomly selected. The paraffin blocks were subsequently collected from the Histopathology Laboratory, Faculty of Veterinary Medicine, Universiti Putra Malaysia, sectioned at 4 µm using a microtome (Reichert-Jung 2045 Multicut Rotary Microtome, Canada) and were then subjected to routine staining using Harris' Haematoxylin and Eosin (H&E). All sections were examined using Olympus CX31 upright microscope attached with Olympus U-CAM3 and Hpx2301 monitor. The associated histopathological changes were identified and described for each condition. The common gross lesions were described based on earlier reports by the pathologists.

RESULTS

Disease Conditions Among Ruminants

A total of 802 cases were selected and analyzed, consisted of 491 (61.2%) goat, 118 (14.7%) cattle, 95 (11.8%) cervine, 75 (9.4%) sheep, and 23 (2.9%) gaur. The three most frequently affected body systems were the same for goat, cattle, sheep, and gaur, which were the circulatory, respiratory, and alimentary systems. In cervine, the musculoskeletal system represented a large percentage of necropsies, which was significantly ($p<0.05$) higher compared to other ruminant species. Besides the musculoskeletal system, two other body systems that were frequently affected in cervine were the circulatory and respiratory systems. Health conditions associated with the integumentary system were the least reported for all ruminant species with an average frequency of 0.2% (Table 1).

Risk Analysis

Risk analysis revealed that health problems associated with the circulatory system was recorded more in cattle, cervine, and gaur with 1.7 times (95% CI= 1.3 - 2.4), 2.2 times (95% CI= 1.4 – 3.3) and 1.7 times (95% CI= 1.1 – 2.5), respectively. Meanwhile, cervine recorded less problem with the alimentary tract and metabolic conditions with 0.3 times (95% CI= 0.1 – 0.7) and 0.2 (95% CI= 0.1 – 0.7) chances, respectively. On the other hand, they were at risk of health conditions associated with the musculoskeletal system with 8.6 times (95% CI= 4.0 – 18.0) more likely compared to other species of ruminants. Risk of health conditions associated with the reproductive system was notable only in goat with 6.5 times more likely (95% CI= 2.0 – 21.6). Goat were 1.6 times (95% CI= 1.5 – 1.7) more at risk of health conditions related to the integumentary system than other species. Cervine were 4.6 times (95% CI= 1.8 – 12.1) more risk of experiencing health conditions in the other body systems. In contrast, goats showed less health conditions in other body systems with decreased odds of 0.3 times (95% CI= 0.1 – 0.8) (Table 1).

Common Health Problems

The most common health problems reported among the 5 ruminant species were attributed to the circulatory (32.6%), respiratory (23.2%), and alimentary (15.1%) systems. Out of 245 cases reported involving the circulatory system, 63.3% were cases of septicaemia, which was significantly ($p<0.05$) high compared to other health problems associated with the circulatory system. The second leading health problem associated with the circulatory system was bacteremia. In the respiratory system, bacterial pneumonia was significantly ($p<0.05$) high at 55.9% while the alimentary system recorded parasitism as significantly ($p<0.05$) high at 51.5% (Table 2).

Table 1: Percentage of total cases classified into each body system based on each species. [a,b,c] indicates at risk (OR>1), not at risk (OR<1), and equal odds (OR=1) of health conditions related to respective body system

Body systems	Goat		Cattle		Cervine		Sheep		Gaur		Total	% mean ±SEM
	n	%	n	%	n	%	n	%	n	%		
Circulatory	133[b]	23.6	48[a]	40.7	38[a]	40.0	18[b]	24.0	8[a]	34.8	245	32.6±3.7
Respiratory	116[a]	27.1	28[a]	23.7	21[b]	22.1	16[b]	21.3	5[b]	21.7	186	23.2±1.1
Alimentary	94[a]	19.1	14[b]	11.9	6[b]	6.3	19[a]	25.3	3[b]	13.0	136	15.1±3.3
Metabolic	49[a]	10.0	13[c]	11.0	3[b]	3.2	9[a]	12.0	1[b]	4.3	75	8.1±1.8
Musculoskeletal	6[b]	1.2	3[b]	2.5	16[a]	16.8	5[a]	6.7	1[c]	4.3	31	6.3±2.8
Hepatobiliary	23[a]	4.7	4[b]	3.4	1[b]	1.1	3[b]	4.0	2[a]	8.7	33	5.3±1.8
Urinary	28[a]	5.7	2[b]	1.7	3[b]	3.2	4[a]	5.3	1[b]	4.3	38	4.0±0.7
Reproductive	30[a]	6.1	2[b]	1.7	0	0.0	1[b]	1.3	0	0.0	33	1.8±1.1
Integumentary	6[a]	1.2	0	0.0	0	0.0	0	0.0	0	0.0	6	0.5±0.2
Others	6[b]	1.2	4[a]	3.4	7[a]	7.4	0	0.0	2[a]	8.7	19	4.1±1.7
Total	491	100	118	100	95	100	75	100	23	100	802	

Table 2: Health problems associated with the circulatory, respiratory, and alimentary tracts of ruminants. [a,b,c] different superscript indicates significant ($p<0.05$) different.

Body systems	Health problems	Cases	Percentage (%)
Circulatory	Septicaemia[a]	155	63.3
	Bacteremia/Bacterial toxaemia[b]	39	15.9
	Viral infection[b,c]	21	8.6
	Poisoning/Toxicity[c]	15	6.1
	Protozoal infection[c]	10	4.1
	Cardiomyopathy[d]	5	2.0
	Total	245	100.0
Respiratory	Bacterial pneumonia[a]	104	55.9
	Pneumonia[b]	58	31.2
	Aspiration pneumonia[c]	11	5.9
	Atypical interstitial pneumonia[c]	5	2.7
	Others[c]	8	4.3
	Total	186	100.0
Alimentary	Gastrointestinal parasitism[a]	70	51.5
	Bloat[b]	24	17.6
	Inflammation[c]	16	11.8
	Impaction[d]	9	6.6
	Malposition[d]	8	5.9
	Others[d]	9	6.6
	Total	136	100.0

Septicaemia

Septicaemia was found to be the most common health problem reported among ruminants between 2006 and 2017. Out of the total 155 cases of septicaemia, bacteria were successfully culture from 85 (54.8%) cases. A total of 39 (45.4%) cases produced single isolation of bacteria, while 46 cases (53.5%) resulted in mixed isolation of bacteria. From the 85 cases, it was revealed that 53 (62.4%) cases involved *E. coli*, 20 (23.5%) cases involved *Klebsiella pneumoniae*, 8 (8.4%) cases involved *Staphylococcus* spp., and 6 (7.1%) cases involved *Pasteurella* spp. In cases of septicaemia caused by single bacterial species, *E. coli* was significantly ($p<0.05$) high compared to *K. pneumoniae* and other bacteria (Table 3).

Bacterial Pneumonia

Bacterial pneumonia was the second most common health problem among ruminants. Out of the 104 cases of bacte

Table 3: Total cases of each bacterium/types of parasite identified from 85, 58, and, 70 cases of septicaemia, bacterial pneumonia, and gastrointestinal parasitism. [a,b,c] different superscript indicates significant ($p<0.05$) different.

Health problems	Isolation	Species / genus of bacteria	Cases	Percentage (%)
Septicaemia	Single	*E. coli*[a]	30/39	76.9
		K. pneumoniae[b]	6/39	15.4
		Others[b]	3/39	7.7
	Mixed	involving *E. coli* [a]	23/46	50.0
		involving *K. pneumoniae*[b]	14/46	30.4
		involving *Staphylococcus* spp.[a]	7/46	15.2
		involving *Pasteurella* spp.[a]	6/46	13.0
	Isolation	Species / genus of bacteria	Total isolation	Percentage (%)
Bacterial pneumonia	Single	*Pasteurella* spp.[a]	14/28	50.0
		E. coli[b]	7/28	25.0
		K. pneumoniae[b]	3/28	10.7
		Others[b]	3/28	10.7
	Mixed	involving *Pasteurella* spp.[a]	13/58	22.4
		involving *Escherichia coli* [a]	13/58	22.4
		involving *K. pneumoniae* [b]	8/58	13.8
		involving *Mannheimia* spp.[b]	5/58	8.6
		Types of parasite	Total isolation	Percentage (%)
Gastrointestinal parasitism		Helminthiasis	59/70	84.3
		Coccidiosis	11/70	15.7

rial pneumonia, 86 (82.7%) cases were subsequently subjected to bacterial isolation and identification resulted in 28 (32.6%) cases with single bacteria, while the remaining 58 (67.4%) cases yielded mixed bacterial isolations. The four most frequently isolated bacterial species were *Pasteurella* spp. (31.4%), *Escherichia coli* (23.3%), *Klebsiella pneumoniae* (12.8%) and *Mannheimia* spp. (5.8%). In pneumonia caused by single bacteria, *Pasteurella* spp. was significantly ($p<0.05$) high. On the other hand, in cases of pneumonia caused by mixed bacterial infection, significant ($p<0.05$) differences were observed between cases involving *Pasteurella* spp. and those involving *K. pneumoniae* and other bacteria species. Similar finding was observed in cases involving *E. coli* (Table 3).

Gastrointestinal Parasitic Infestation

Majority of the post-mortem records had no additional laboratory tests to either identify the species of parasite or the parasitic burden of the animal. However, the records did state the definitive diagnosis without providing complete post-mortem findings to support the diagnosis. Only two classifications were made available from all the related records, which were helminthiasis and coccidiosis. Most cases of parasitic infestation were caused by helminths (84.3%) while the remaining was caused by coccidia (Table 3)

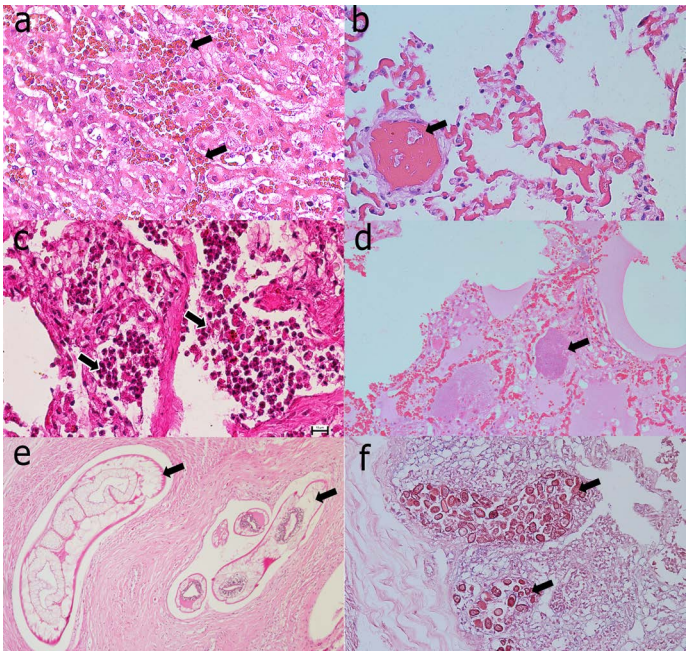

Figure 1: Common histopathological lesions observed in septicaemia (a-b), bacterial pneumonia (c-d), and gastrointestinal parasitic infection (e-f). (a) congestion (arrows) of liver. (b) disseminated intravascular coagulation (arrows) in the lungs.(c) presence of inflammatory cells (arrows) in the alveolar spaces. (d) presence of bacterial colonies (arrow) and pulmonary oedema. (e) cross section of helminthes (arrows) in the gastrointestinal tract. (f) presence of different stages of protozoa (arrows) in the intestinal mucosa.

Gross and Histopathology Lesions

For septicaemia, the gross lesion that was frequently reported was congestion of multiple organs, and pulmonary oedema. Histologically, these were observed as the presence high number of red blood cells in blood vessels of lungs, liver (Figure 1a) and spleen, disseminated intravascular coagulation (Figure 1b) and presence of homogenous pink substance in the alveolar space (Figure 1b).

For bacterial pneumonia, pulmonary oedema, emphysema, congestion, and pulmonary abscessation were the most commonly reported gross lesions. Histological findings included pulmonary congestion and oedema, presence of inflammatory cells (Figure 1c) and presence of bacterial colonies in the alveolar spaces (Figure 1d).

For gastrointestinal parasitic infestation, presence of helminths was frequently reported. In case of gastrointestinal coccidiosis, commonly reported findings were presence of whitish nodular lesions at the serosa and mucosa, intestinal haemorrhage, and congestion. Histologically, helminths (Figure 1e) and different stages of coccidia (Figure 1f) were observed, accompanied by mucosal necrosis.

DISCUSSION

This retrospective study identifies the common health problems in ruminants based on the records of post-mortem examinations. This method has been long practiced (Holler and De Morgan, 1970), and is invaluable since it is capable of providing large amount of data to perform surveillance on health and disease conditions (Küker et al., 2018). This study involved 844 cases with 20.6% were not suitable for analysis due to missing physical reports, autolyzed carcasses and samples, and inconclusive diagnosis. This resulted in reduced optimal use of the data. The use of electronic forms for data entry, and to set a maximum limit of post-mortem intervals to avoid performing post-mortem examination on autolyzed carcasses might improve data for analysis. The latter could also aid in misinterpretation of lesions that has been distorted or obscured by post-mortem changes (Brooks, 2016).

Septicaemia was observed as the most frequently reported health problem among ruminants in this study. It was most commonly caused by Gram-negative bacteria, especially *E. coli*. The same pattern was previously observed in companion animals in Malaysia (Rathiymaler et al., 2017; 2019). Invasive serotypes of enterotoxigenic *E. coli* (ETEC) that is present in the intestinal tract of an animal has virulence properties that allows it to cross the mucous membrane and cause septicaemic colibacillosis in animal (Acheson and Luccioli, 2004). It has been concluded that the prevalence rate of *E. coli* infection in calves may varies according to the geographical locations (Cho and Yoon, 2014). The current study and a previous study among sheep farms in Pahang, Malaysia, suggested that prevalence of *E. coli* infection was high (Rosilawati et al., 2016).

The second health problem commonly reported in ruminants is bacterial pneumonia. From this study, the most common bacterium isolated from cases of bacterial pneumonia in ruminants was *Pasteurella* spp. Numerous studies have reported that bacterial pneumonia in ruminants are common globally. It is a known opportunistic commensal bacterium found in the upper respiratory tract of ruminants (Shayegh et al., 2009; Fitri et al., 2017). It typically causes pulmonary infections in ruminants under stressful conditions. Detailed study should be conducted in serotyping and characterization of this microorganism since it is known that certain serotypes are known to be more prevalent in certain species of ruminant.

The third commonly reported health problem in ruminants was gastrointestinal parasitism. This study revealed only two types of gastrointestinal parasitism, the helminthiasis and coccidiosis. In Southeast Asia, the highest prevalence of gastrointestinal parasite found in small ruminants were *Haemonchus contortus* and *Trichostrongylus* spp. (Waller and Chandrawathani, 2005). Other parasites such as *Strongyloides papillosus*, *Oesophagostomum* spp., and *Moniezia* spp. were reported but with lower prevalence rates. The high prevalence of gastrointestinal parasitism among ruminants in Malaysia has been previously highlighted (Tan et al., 2017), particularly in sheep compared to goat and deer. These were due to the pressing issue of severe anthelmintic resistance that has been reported among ruminants in Malaysia, South East Asia, as well as other countries in the world (Waller, 1997; Várady et al., 2011; Chandrawathani et al., 2013).

CONCLUSIONS

The study successfully identified common health problems among ruminants namely septicaemia, bacterial pneumonia and gastrointestinal parasitism. Gram-negative bacteria such as *E. coli*, *Pasteurella* spp., and *K. pneumoniae* were found to be important species/genus contributing to occurrence of septicaemia and/or bacterial pneumonia in ruminants. Data collected from this study would be a valuable resource for the formulation of more effective preventive measures or strategies against these commonly reported diseases.

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AUTHORS CONTRIBUTION

MZ and BSF conducted the study and preparation of manuscript, while MZS and AS involved in the study design and revision of manuscript.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article.

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