Australian and New Zealand College of
Veterinary Scientists

Membership Examination

June 2021

Veterinary Epidemiology

Paper 1

Perusal time: **Fifteen (15)** minutes

Time allowed: **Two (2)** hours after perusal

Answer **ALL EIGHT (8)** questions

Answer **EIGHT** questions, each worth 15 marks ....total 120 marks

Paper 1: Veterinary Epidemiology

Answer all eight (8) questions

1. Answer **all** parts of this question:

   a) Explain why epidemiologists study the causes of disease. *(3 marks)*

   b) Describe the component cause model of causation, ensuring that definitions for key terms are provided in your answer. *(6 marks)*

   c) Koch's postulates are an early example of a criteria-based approach to causal inference. List Koch's postulates and describe their limitations when investigating causal relationships. *(6 marks)*

2. You visit a dairy cattle producer to discuss some of the health problems in her herd.

   Answer **all** parts of this question:

   a) On the day you visit, there are 31 cows with mastitis among the 780 cows in milk (lactating) on that day. Calculate and interpret an appropriate measure of disease frequency. *(3 marks)*

   b) Of the total 840 cows in the herd, 116 have experienced at least one episode of mastitis during their most recent lactation. Eleven of these cows are among the 5% of the herd that produce the lowest volumes of milk per head. Calculate and interpret an appropriate measure of association. *(5 marks)*

   c) Calculate the proportion of cases in the herd that could be prevented if the 5% of cows that produce the lowest volumes of milk were removed from the population. Please show your calculation. *(4 marks)*

   d) Explain how you would use confidence intervals to further interpret each of the measures calculated in parts 2 a) and b). *(3 marks)*

Continued over page

3. Describe the key steps in a risk analysis conducted to help a zoo veterinarian manage disease risks associated with the introduction of birds from the wild into a captive breeding colony in the zoo collection. Assume that the zoo already holds some birds of the same species, and several closely related species that may be susceptible to the same pathogens. For the purpose of this question, do not actually perform the risk analysis, rather, show your understanding of each step. *(15 marks)*

4. *Mycoplasma bovis* is a bacterium that can cause a range of serious conditions in cattle, including mastitis that does not respond to treatment, pneumonia, arthritis, and late-term abortions. In 2017 the disease was found in New Zealand (NZ) for the first time. The bacterium is an Unwanted Organism under the NZ Biosecurity Act 1993 and the NZ Ministry of Primary Industry launched an eradication programme in response.

   Answer **all** parts of this question:

   a) List and briefly explain general prerequisites for a successful eradication programme. *(10 marks)*

   b) Briefly outline the key differences between a control program and an eradication program. *(3 marks)*

   c) List **one (1)** example of an animal health control program and **one (1)** example of an animal health eradication program (not *Mycoplasma bovis* in NZ) either on regional, national, state or district level. For each program ensure that disease name, geographic area and the level (regional, national, state, district) of the program is stated. *(2 marks)*

5. Answer **all** parts of this question:

   a) Define the term surveillance. *(2 marks)*

   b) List **five (5)** potential objectives for conducting disease surveillance, providing a brief example of each. *(5 marks)*

   c) Use examples to explain why data from passive surveillance systems may not accurately represent disease distribution in the population of interest. *(8 marks)*

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6. Answer **both** parts of this question:

a) Describe in detail the economic analysis: **partial farm budgeting**. *(4 marks)*

b) Define **net present value** *(2 marks)* and calculate this value given the following information. Show your workings. *(9 marks).*

A vaccination campaign is conducted over 3 years. In the first year the undiscounted costs are $10 million, and the undiscounted benefits are $0; in the second year the undiscounted costs decrease to $5 million, and the undiscounted benefits increase to $5 million and in the third year the undiscounted costs decrease further to $2 million, and the undiscounted benefits increase to $15 million. The interest rate is 3%.

$$Present\ value = \frac{Future\ value}{(1 + \frac{interest\ rate}{100})^{number\ of\ years\ in\ the\ future}}$$

Continued over page

7. The veterinary services in your country are planning a disease eradication program for an important disease of pigs. The only diagnostic test available has a diagnostic sensitivity of 62% and a diagnostic specificity of 95%.

Answer **all** parts of this question:

a) State the probability of this diagnostic test correctly classifying an infected animal as infected. *(1 mark)*

b) Define the terms **positive predictive value** and **negative predictive value**. *(2 marks)*

c) Describe, using an example to illustrate, how these predictive values will change at the individual animal-level as true prevalence decreases over the course of an eradication program using this diagnostic test. *(5 marks)*

d) Describe the information needed to calculate the herd-level sensitivity, and how this diagnostic test would be applied at the herd level to maximise herd sensitivity. *(7 marks)*

8. Answer **all** parts of this question:

a) Describe the key means of transmission for an infectious disease of your choice. *(3 marks)*

b) List the control strategies that you would recommend to prevent transmission of this disease. *(3 marks)*

c) If an infectious disease was introduced into a new area, identify factors that would determine whether or not an epidemic results. *(4 marks)*

d) Explain how these factors relate to the basic reproductive rate and herd immunity. *(5 marks)*

End of paper

Australian and New Zealand College of Veterinary Scientists

Membership Examination

June 2021

Veterinary Epidemiology
Paper 2

Perusal time: **Fifteen (15)** minutes
Time allowed: **Two (2)** hours after perusal

Answer **ALL THREE (3)** questions

Question 2 e) requires answering in your answer booklet and not on this question paper
Question 3 requires the review of excerpts from the journal article provided.

Answer **THREE** questions, each worth 40 marks.......................................total 120 marks

Paper 2: Veterinary Epidemiology

Answer all three (3) questions

1. A colleague works in clinical practice in rural Australia. She has come across an article promoting a new treatment ('new eye') for equine recurring uveitis using a case series of successful applications. Your colleague is not convinced of the treatment and, furthermore, she is concerned that there might be considerable side effects. She approaches Equine Veterinarians Australia, a special interest group of the Australian Veterinary Association, who ask her to document her concerns. Since you are an experienced epidemiologist, she asks you for help.

Answer **all** parts of this question:

a) Discuss, using your understanding of the 'hierarchy of evidence', the strength of the evidence provided by the case series that supports the new treatment. *(5 marks)*

b) Indicate the type(s) of situation(s) where a case report might be considered to be a suitable source of information. Justify your answer. *(5 marks)*

You are interested to know just how many veterinarians are already using the new treatment. You decide to research this yourself using a questionnaire to collect this information.

c) Define a suitable objective for this research. *(2 marks)*

d) List the information required to estimate the sample size required for this research. *(3 marks)*

e) Identify and concisely describe (using the context outlined in this question) an appropriate sampling method for this particular research. *(10 marks)*

You decide that you would also like to reliably assess the effectiveness of the new treatment.

f) Can the effectiveness of the new treatment be determined by your research using the questionnaire? Justify your answer. *(5 marks)*

g) Identify and describe **one (1)** alternative study design that might be used to assess the effectiveness of the new treatment. Compare the proposed study design to the aforementioned research with the questionnaire, with respect to the level of evidence. *(10 marks)*

Continued over page

2. A new enzyme-linked immunosorbent assay (ELISA) has been developed to detect antibodies against a novel coronavirus found in bats. Serum samples are available following an infection trial from bats known to have been infected several weeks prior and bats known to be uninfected. The test has been run and the results are presented in the table and plots that follow.

Table 2.1: Summary statistics of antibody unit (AU) counts comparing bats infected with a novel coronavirus to known uninfected bats.

Group	n	arithmetic mean	SD	median	min, max
Known infected	30	901.1	3592.2	83.5	0.3, 33283
Known uninfected	60	16.3	20.2	9.3	0.9, 136.5

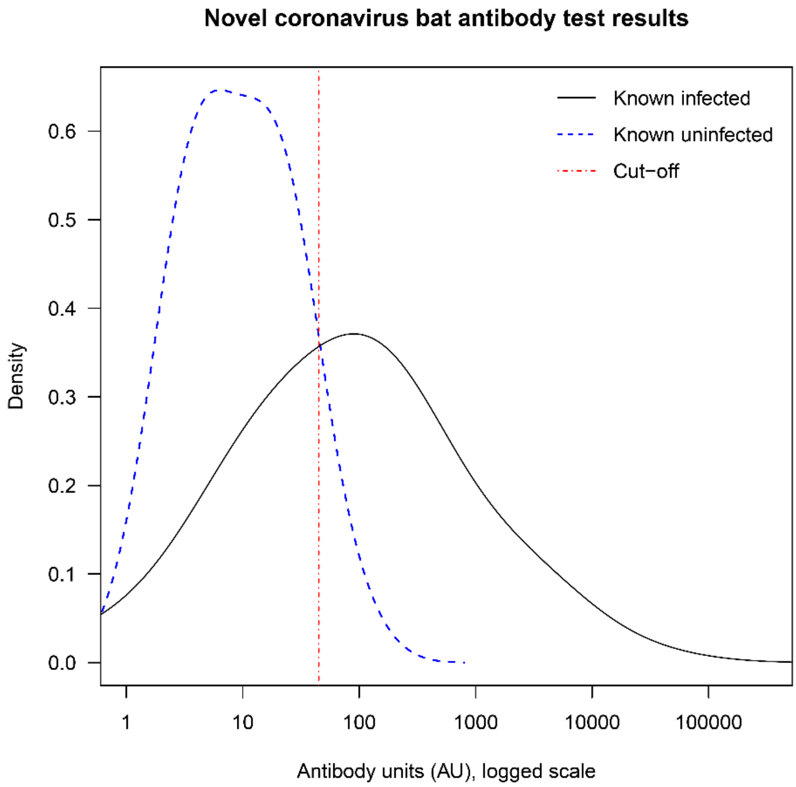

Figure 2.1: Plots of the distribution of antibody units (AU) comparing bats infected with a novel coronavirus (black solid line) to known uninfected bats (blue dashed line). A proposed cut-off for a new ELISA is shown as the red dot-dash vertical reference line at 45 AU. Note: the X-axis is on a logged scale.

Question 2 continued over page

Answer **all** parts of question 2:

a) State whether the data might be considered to be positively skewed, negatively skewed or not skewed. Provide appropriate justification for your answer. *(6 marks)*

b) Explain, with justification, which summary statistics are most appropriate to describe:

   i. the central tendency of these data *(2 marks)*

   ii. the distribution of these data. *(2 marks)*

c) Select and justify the choice of parametric or non-parametric tests to compare the two groups. Provide justification for your answer, including what may occur if an inappropriate statistical test is chosen. *(10 marks)*

d) These AU counts represent a numerical variable on a discrete scale. List the other main scales of epidemiological data and briefly describe the main characteristics of each. *(6 marks)*

e) Based on the 45 AU cut-off on the diagram, identify which of the following are true positives, false positives, true negatives and false negatives (answer in provided answer booklet): *(4 marks)*

   i. the region below the cut-off for known infected bats

   ii. the region above the cut-off for known infected bats

   iii. the region below the cut-off for known uninfected bats

   iv. the region above the cut-off for known uninfected bats.

f) Describe what will happen to the diagnostic sensitivity and specificity of the assay if the cut-off is moved to 200 AU. *(4 marks)*

g) Describe whether a higher or lower cut-off would be more desirable for screening versus confirmation purposes. *(4 marks)*

h) Describe whether a higher diagnostic sensitivity would be achieved by using this new test in series versus parallel with another reasonably accurate test. *(2 marks)*

Continued over page

3. Evaluate the excerpts provided in **attachment 1** on the following pages from a scientific publication, and answer the question below.

Note, parts of the publication have been redacted; all text relevant to the questions is provided.

Answer **all** parts of this question:

a) Describe the evidence presented by answering the following questions:

   i. Specify the population of interest (P) as well as the main exposures or interventions (I/E) and the main outcome (O) measured. *(3 marks)*

   ii. Using P, I/E and O, identify and state the main research question of this study. *(3 marks)*

   iii. Identify and state the study design used by the authors. *(2 marks)*

   iv. Interpret the results presented in Table 3 taking confidence intervals and p-values into account. *(7 marks)*

b) Assess the internal validity of the study with regard to bias, confounding, chance and causal explanations (e.g., Hill's criteria). *(15 marks)*

c) Assess the external validity of the study. Provide a rationale for your conclusion. *(10 marks)*

Attachment 1 over page

<u>Attachment 1:</u> parts of the publication have been redacted; all text relevant to the questions is provided

Gunther, M. J., et al. "Dairy goat producers' understanding, knowledge and attitudes towards biosecurity and Q-fever in Australia." Preventive Veterinary Medicine 170 (2019): 104742.

Abstract:
The Australian dairy goat sector is an emerging animal industry undergoing rapid expansion. Limited information is available within this industry in relation to socio-demographic characteristics and biosecurity implementation. Q-Fever, caused by the bacterium *Coxiella burnetii*, is a zoonotic disease endemic in Australia, with a range of domestic and wild-animal reservoir species, including goats, with infected pregnant goats posing a significant public health risk. The aim of the current study was to investigate the socio-demographics of Australian dairy goat producers and their biosecurity implementation. To achieve this aim, a study was conducted, using an online survey among dairy goat producers. A total of 106 goat producers participated in the online survey (35.3% response rate). Findings from this study suggest that most goat producers implement biosecurity practices related to direct animal husbandry, such as separating sick goats (86%), vaccinations (79%) and providing separate kidding space (75%); and, practices minimizing the risk of disease introduction, such as maintaining boundary fences (86%) and isolating incoming animals (67%). However, implementation of other biosecurity practices, such as keeping records of visitors and visitor biosecurity requirements, was inadequate. A multifaceted approach is necessary to increase knowledge, understanding and perception of risk surrounding Q-fever, and promote positive uptake of biosecurity measures, for improved outcomes for animal and human health.

Materials and Methods:
A study was conducted using an online questionnaire, to obtain baseline data of characteristics and practices of dairy goat producers. The questionnaire was written in English and consisted of five key sections with 45 questions in total. These sections included: demographics, biosecurity practices, on-farm animal husbandry activities, Q-Fever knowledge, and information sources for biosecurity, animal health and zoonotic disease. The questionnaire comprised short closed, semi-closed and open-ended questions to improve accuracy of responses by providing participants with the ability to qualify or quantify responses (Thrusfield and Christley, 2018). The questionnaire was available electronically via Survey Monkey® (San Alto, California, USA) and was open to participants for a six-week period between July and September 2016. A copy of the questionnaire is available from the corresponding author upon request.

Excerpt continued over page

As an accurate register of dairy goat producers in Australia is not available, the source population for this study were the 300 producers whose emails were available from a public list obtained via the Dairy Goat Herd Health Book of Australia (The Dairy Goat Society of Australia Limited), which included commercial and smallholder producers. Considering the size of the source population, the number of required responses was determined assuming approximately 30% of producers would conduct a specific practice (estimated prevalence), 95% level of confidence and 10% precision of the estimate and using the sample-size calculation for estimating a single proportion (Dohoo et al., 2009). According to this calculation, a total of 64 responses were required. Goat producers were invited to complete the online questionnaire via an email containing an encoded weblink, which included an information statement to aid clarity and improve accuracy of results (Dohoo et al., 2009).

Data from completed online questionnaires were analysed using IBM SPSS Statistics (©IBM Corp. in Armonk, NY). The variables considered were:

- Demographics (age, farm location, number of goats, main reason for keeping goats, number of years working with goats, and education level);
- Biosecurity practice implementation
- Knowledge of Q-Fever (including vaccination status), and
- Q-Fever information sources.

Responses to both, open and closed-ended questions were coded into dichotomous variables. The binary outcome 'Biosecurity practice implementation' was created based on implementation of 15 practices listed in the questionnaire. An arbitrary cut-off based on the upper quartile of the distribution of number of practices implemented was used to categorize producers. Participants who employed a minimum of nine (out of the 15 practices listed) of the key-identified practices were recoded into the binary outcome of 'good' 'biosecurity practice implementation'. Participants who failed to adequately implement nine practices were recorded into the binary outcome of 'poor' 'biosecurity practice implementation'. Univariable logistic regression analyses were used to identify potential factors associated with biosecurity implementation. Explanatory variables investigated were demographic characteristics (age, gender, location [by State], level of post high school education), production system variables (motivations for owning goats, number of years working with dairy goats, farm size), knowledge of Q-fever (heard of Q-fever, vaccination status) and information sources used for Q-Fever ('Referenced Sources' [academic, government, medical and veterinary] and 'Non-referenced sources' [word of mouth, webpages, media and television, and social networking sites]). Those associations between explanatory variables and the outcome of the model with a p-value< 0.05 were considered significant. Multivariable analysis was considered; however, it was not used due to the limited associations found at a univariable.

Excerpt continued over page

Results

A total of 106 goat producers participated in the online survey (35.3% response rate) however, 18 participants had missing values for questions that formed the outcome variables, and therefore were excluded from the analysis. Overall, most respondents were female, over 50 years of age and with formal post high school education. The median number of years of experience working with dairy goats was 10 (range six months to 66 years). The average number of goats kept across all properties was 52, with herd numbers ranging from 4 to 2500 milking goats and a median herd size of 12 goats. Forty-four percent of respondents indicated that the reason for keeping goats was economic. Results indicate that the majority of goat producers (68%) have a 'good' uptake of biosecurity. Table 3 (following page) presents the proportion of producers implementing 'good' or 'poor' biosecurity according to key demographic characteristics.

Excerpt continued over page

Table 3

Proportion of producers implementing good biosecurity (at least 9 out of 15 key biosecurity practices) according to key demographic characteristic among 88 Australian dairy goat producers participating in a study in 2016.

Demographic characteristics	'Good' biosecurity practice implementation, n (%)	Odds ratio (95% CI)	P-value
State			0.903
NSW	20/26 (77)	(ref)	
VIC	13/21 (62)	0.48 (0.1-1.7)	
QLD	15/22 (68)	0.48 (0.1-1.7)	
SA	2/3 (67)	0.60 (0.1-7.8)	
WA	6/10 (60)	0.45 (0.1-2.1)	
TAS	4/4 (100)	.	
Age			0.016
18-25	0/4 (0)	.	
26-35	5/5 (100)	.	
36-49	13/17 (77)	2.17 (1.2-9.9)	
50-64	28/39 (72)	1.7 (1.1-5.9)	
65+	9/15 (60)	(ref)	
Education			0.246
Formal education post-high school	44/61 (72)	1.88 (0.7-5.5)	
No formal education post high school	11/19 (58)	(ref)	
Gender			1
Female	55/80 (69)	1 (0.3-3.2)	
Male	11/16 (69)	(ref)	
Number of years working with dairy goats			0.241
≥5	18/27 (67)	(ref)	
6-10	14/17 (82)	2.33 (0.5-10.3)	
11-20	11/16 (69)	1.1 (0.3-4.1)	
21-30	5/11 (46)	0.42 (0.1-1.7)	
31-40	10/12 (83)	2.5 (1.2-13.9)	
>40	2/5 (40)	0.33 (0.1-2.4)	
Main reason for keeping goats			0.465
Primary Income	7/8 (88)	(ref)	
Secondary/Extra Income	6/7 (86)	0.86 (0.1-16.9)	
Hobby	14/19 (74)	0.4 (0.1-4.1)	
Milk for Secondary products	8/11 (73)	0.38 (0.0-4.6)	
Show Goats	5/10 (50)	0.14 (0.0-1.6)	
Goat milk for household use	19/30 (63)	0.25 (0.0-2.3)	
Goat milk for pets	1/3 (33)	0.07 (0.0-1.7)	
Dairy goat-related income			0.516
Yes	28/39 (72)	1.75 (0.7-4.2)	
No	32/54 (65)	(ref)	
Farm size			0.290
<30 goats	43/66 (65)	0.55 (0.2-1.7)	
>30 goats	17/22 (77)	(ref)	

End of paper