Meta-Analysis and One Health

Mark Stevenson
Faculty of Veterinary and Agricultural Sciences
The University of Melbourne
Parkville Victoria 3010 Australia
mark.stevenson1@unimelb.edu.au

Ahmad Rabiee
Cow Signals Australia
Denham Dr
Horsley New South Wales 2530 Australia
ahmad@cowsignalsaustralia.com.au

Introduction

The emergence of several new and re-emerging infectious diseases over the past 20 to 30 years has been an ongoing cause for concern in the health professions leading to calls for collaborative action.

These calls embody the concept of *One Health* which aims to improve health and well-being through mitigation of risks and crises that originate at the interface between humans, animals and their various environments [1].

As a paradigm, the One Health approach attempts to synthesise observations and inferences across a series of complex systems. Systematic reviews and meta-analyses are tools eminently suited to assist with these tasks, but, to the best of our knowledge, examples of their use in a One Health context are few.

Background

Meta-analysis has been defined as the statistical analysis of a large collection of analysis results from individual studies for the purpose of integrating the findings [2].

Meta-analysis is a formal method of epidemiologic study design used to provide a synthesis of a body of research. The technique is now routinely used in social, medical, biological and environmental sciences.

Outcomes from a meta-analysis typically include a more precise estimate of the effect of an intervention on an outcome and identification of sources of heterogeneity among a set of trials. Forest plots (Figure 1) provide a useful summary of the results of a meta-analysis.

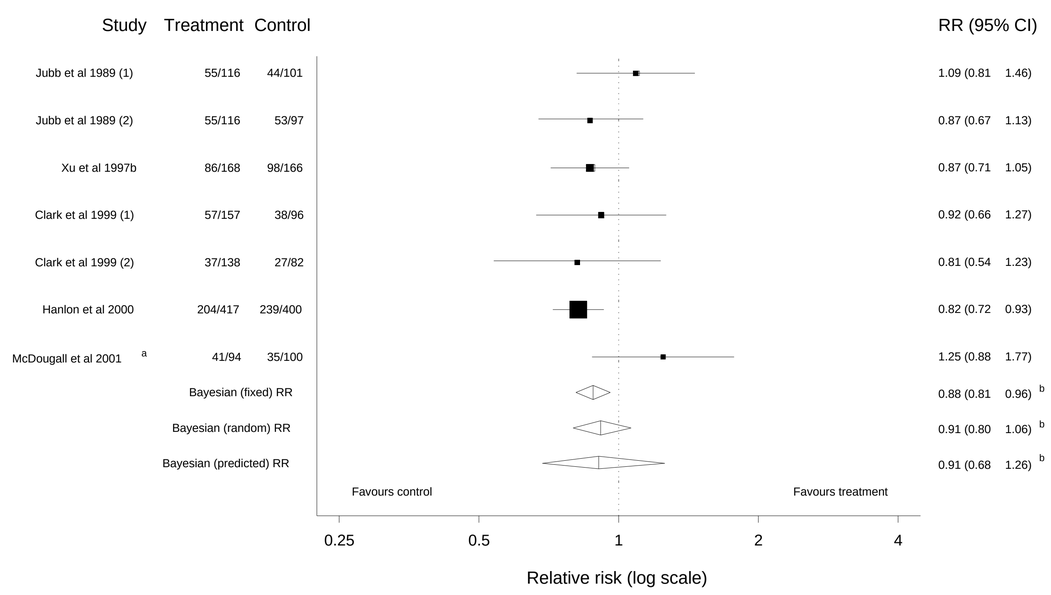

Figure 1: Relative risks (and their 95% confidence intervals, CI) determined from the results of six trials comparing first service conception rates in non-cycling dairy cows treated with controlled internal drug-releasing devices or placebo [3]. Summary estimates of treatment effects are shown using: (1) a Bayesian (fixed-effects) approach; (2) a Bayesian (random-effects) approach; and (3) the predicted distribution of relative risk estimates expected in a future trial. Test of heterogeneity: χ^2 = 8.53, *df* = 6; P = 0.20.

The potential value of meta-analysis in a One Health context

There are three ways in which meta-analyses might provide addtional insight when investigating issues in a One Health context:

- To confirm general patterns of effect across populations and species and to resolve controversies arising from competing hypotheses.
- To identify sources of heterogenetiy (e.g. different types of traits or methodologies) among seemingly inconsistent results from a set of primary studies.
- To quantify effect sizes for hypothesised relationships.

Putting it into practice

Choose the subject matter of your One Health meta-analysis with care. Suitable topics might include drug therapies used in a number of species with a consistent outcome of interest across species (e.g. bacteriological cure rates) or risk factors for common exposures and outcomes across species, for example the influence of average daily energy intake (e.g. on a per kilogram basis) on an adjusted measure of longevity.

As with any meta-analysis, a check for study heterogeneity using either Cochrane's Q or Higgin's I^2 is an essential part of the analytical process.

In the likely event that heterogeneity is found stratified analyses by species should be carried out. In the hypothetical data shown in Table 1 it can be seen that the chemotherapuetic agent under investigation is associated with a consistent, increased risk of therapeutic success in all species except for cats. A logical extension of this work would be to identify reasons for therapeutic failure in cats.

Variable	Number of studies	Pooled risk ratio	P value
Study design:			
Cohort	10	1.21 (1.14 to 1.30)	<0.01
Case-control	18	1.51 (1.26 to 1.81)	<0.01
Species:			
Man	9	1.22 (1.10 to 1.35)	<0.01
Bovine	6	1.24 (1.15 to 1.34)	<0.01
Canine	5	1.78 (1.29 to 2.05)	<0.01
Feline	8	0.80 (0.65 to 1.05)	0.25

Table 1: Results of a hypothetical meta-analysis to quantify the effect of a chemotherapeutic agent on therapeutic success. Studies have been stratified by design and species.

Conclusions

Application of a One Health approach to meta-analysis has the potential to enhance our understanding of issues influencing the health and wellbeing of humans, animals and their various environments.

It is unlikely that meta-analyses will be useful in all One Health situations. Exposures and outcomes of interest need to be selected with care. Detecting and understanding reasons for study heterogeneity are likely to be the key benefits from One Health meta-analyses.

References

[1] FAO and OIE and WHO and UN System Influenza Coordination and UNICEF and The World Bank, *Contributing to One World, One Health A Strategic Framework for Reducing Risks of Infectious Diseases at the AnimalHumanEcosystems Interface*. Rome, Italy: Food and Agriculture Organization of the United Nations.

[2] G. Glass, "Primary, secondary and meta-analysis of research," *Educational Researcher*, vol. 5, pp. 3 – 8, 1976.

[3] A. Rabiee, I. Lean, and M. Stevenson, "A Bayesian meta-analysis of the effects of administering an intra-vaginal (CIDR) device in combination with other hormones on the reproductive performance of cycling, anoestrous and inseminated cows," *New Zealand Veterinary Journal*, vol. 52, pp. 384 – 393, 2004.