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Theriogenology 66 (2006) 534–542
Theriogenology
www.journals.elsevierhealth.com/periodicals/the

Critical evaluation of scientific articles and other sources of information: An introduction to evidence-based veterinary medicine

J.P. Kastelic *

Agriculture and Agri-Food Canada, Lethbridge Research Centre, Box 3000, Lethbridge, AB, Canada T1J 4B1

Abstract

The purpose of this paper is to briefly review key concepts regarding critical reading of the scientific literature to make informed decisions, in the context of evidence-based veterinary medicine. Key concepts are reviewed, based on the broader experience in human medicine, with adaptations, as indicated, to veterinary medicine. That a paper has been published in a peer-reviewed journal does not guarantee its credibility; guidelines are given regarding the general merit of different kinds of articles, as well as checklists and criteria that can be used to assess a paper. Specific study designs, their merits and limitations, are briefly discussed. Standard numerical indices for assessment of studies involving treatments and for assessments of diagnostic tests are summarized. Criteria for assessing drug trials are presented. The principles of statistical analysis are described, including practical considerations and common errors. Finally, numerous sources of bias are reviewed.

Keywords: Evidence-based veterinary medicine; Experimental design; Clinical tests; Diagnostic tests; Statistical analysis

1. Introduction

In 1992, it was estimated that only 4% of therapeutic decisions in human medicine were based on strong evidence from clinical studies, 45% were based on minimal evidence from studies but strong clinical consensus, and the remaining 51% were based on personal opinion [1]. However, we are currently living in the 'information age'; new information is being discovered and communicated at an ever-increasing rate. Due to the current availability of information and the relative ease with which it can be accessed, leading-edge practitioners (in both medical and veterinary practice) have an unprecedented opportunity (indeed a responsibility) to incorporate current, accurate information into their day-to-day activities. The purpose of this paper is to briefly review key concepts regarding critical reading of the scientific literature (and other sources of information), to make informed decisions. Since this article is intended primarily for veterinary practitioners, it will emphasize evidence-based veterinary medicine, and will draw heavily on two sources that cover this topic from the perspectives of human [2] and veterinary [3] medicine, respectively. Where appropriate, the discussion has been changed to refer to animals (in lieu of humans) as patients.

2. Evidence-based medicine

The term 'evidence-based medicine' was coined by Sackett et al. [4]. The process of evidence-based medicine follows five key steps [4]:

* Tel.: +1 403 317 2236; fax: +1 403 382 3156.
E-mail address: Kastelicj@agr.gc.ca.

0093-691X/$ – see front matter © 2006 Elsevier Inc. All rights reserved.
doi:10.1016/j.theriogenology.2006.04.017

(1) Identify a clinical problem and express it as an answerable question.
(2) Search for the best evidence to answer the question.
(3) Critically appraise the evidence for validity and clinical relevance.
(4) Integrate this appraisal with clinical experience to formulate the best decision for the clinical problem.
(5) Evaluate the practitioner's performance by relating clinical decisions to the best available evidence.

With the increasing prominence of evidence-based medicine, a similar approach is also being used in veterinary medicine. However, the primary difference between evidence-based medicine and evidence-based veterinary medicine is that in the latter, the emphasis must be necessarily placed on poorer sources of evidence [3].

A common misunderstanding is to equate evidence-based medicine with randomized clinical trials. However, less than 14% of published scientific articles are randomized trials, observational studies are overlooked and patient preferences, clinical circumstances and clinician's expertise are undervalued [5]. Thus, evidence-based medicine should rely on multiple sources of information.

To practice evidence-based medicine, the appropriate sequence of events is to ask the correct question, acquire the information, appraise its quality, apply the results, and ultimately act on the patient [3]. It is essential to start by asking the right question. Categorize the question being asked. Establish priorities, including what is the most important for the patient. Determine what question has the greatest benefit for the lowest cost (i.e. time and resources). When formulating a question, you should take into account the following [3,6]:

(1) The patient or the problem; the evidence should be as similar as possible to the current situation, taking into account age, breed, primary problem, and the population to which the patient belongs.
(2) The intervention or exposures must be defined to guide the choice of the appropriate study design; it could be a diagnosis, therapeutic intervention, prognostic factor, or exposure.
(3) The control group. Define the alternative; it may be one drug versus another drug, or one drug versus no treatment. It may be a comparison of two diagnostic tests. It is often useful to consider what you would do as an alternative (including doing nothing).
(4) The clinical outcome; it must be important enough to influence the clinical decision. This could involve the patient, the owner, or both. Define what you hope to accomplish, measure, improve or affect, and the timeframe during which you expect it to occur.

3. Assessing the validity and value of a publication

The peer-review system is far from perfect; unfortunately, many poor-quality papers are published in peer-reviewed journals. That a paper appears in a peer-reviewed journal is not a guarantee that it is credible and useful. In a recent article detailing errors and shortcomings in scientific papers, it was concluded that 51 of 67 (76%) of articles published in a well-recognized journal were flawed [7]. The following are common reasons why papers are rejected [2]: failure to examine an important scientific issue; lack of novelty; failure to test the stated hypothesis; inappropriate study design; compromised conduct of study (bias or confounding); inadequate sample size; no, inadequate or inappropriate controls; inappropriate statistical analysis; unjustified conclusions; conflict of interest; and poor writing.

It is noteworthy that not all reports are regarded as being of equal value. In general, articles are ranked in descending order of reliability as follows [8]: systematic reviews and meta-analyses, randomized clinical trials with definitive results, randomized clinical trials with non-definitive results, cohort studies, case–control studies, cross-sectional surveys, and case reports.

It has been stated that papers can be discounted even before you have read the results section [2]. As a reader, there are three preliminary questions that you should ask [2]:

(1) What was the impetus for the study and what hypothesis (if any) was tested? The introduction should include a brief explanation of what is known and how the authors propose to modify or extend current knowledge or to provide new information. There should be a clear objective (ideally a hypothesis), indicating what is being tested. It is noteworthy that some studies (e.g. qualitative research, case reports) are not expected to have a hypothesis.
(2) What was the study type? Primary studies include experiments, clinical trials and surveys, whereas secondary research includes reviews (systematic or non-systematic) and meta-analyses, clinical guidelines, decision analyses, and economic analyses.
(3) Was the design appropriate?

Once you have evaluated the paper according to the criteria noted above, and if it still holds your interest,