Training Evidence-Based Veterinary Medicine by Collaborative Development of Critically Appraised Topics

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ABSTRACT

In current veterinary education, skills such as retrieving, critically appraising, interpreting, and applying the results of published scientific studies are rarely taught. In this study, the authors tested the concept of team-based development of critically appraised topics (CATs) in training students in evidence-based veterinary medicine (EBVM). The 116 participants were in their fifth year and attending the clinical rotation at the Clinic for Animal Reproduction. Students developed 18 CATs of varying quality on topics of their choice. Preparing the CATs in teams stimulated discussion on the topic and the quality of the retrieved papers. Evaluation of the project revealed that more than 90% of the students endorsed training in critical appraisal of information in veterinary education. In addition, more than 90% considered the development of CATs an effective exercise for assessing the quality of scientific literature. A provided literature evaluation form was perceived as a useful tool for systematically summarizing a publication's quality. In conclusion, team-based development of CATs during clinical rotations is highly valuable for training in EBVM. Learning and intrinsic motivation seem to be enhanced by creating a situation similar to veterinary practice because the task is embedded into an authentic clinical problem. This approach to clinical training helps to prepare students to integrate evidence from literature into practice.

Key words: evidence-based veterinary medicine, veterinary education, critically appraised topics

INTRODUCTION

Several authors[1–3] have pointed out the need to train veterinary students in evidence-based veterinary medicine (EBVM). The aim of EBVM is to base decisions concerning diagnoses and treatments in veterinary practice on valid, clinically relevant research data.[4] Hence, students have to gain expertise in retrieving, critically appraising, interpreting, and applying the results of published scientific studies.

The body of knowledge in veterinary medicine continues to grow logarithmically,[5] coupled with increased access to the Internet, which provides an overwhelming amount of information.[1,2] Hence, it seems to be impossible for an individual veterinarian to find valid and specific information regarding a certain clinical question in a reasonable amount of time. In addition, the quality of studies published in peer-reviewed journals varies tremendously.[6–8] The practitioner's task is to judge specific information and to decide whether it is applicable and suitable for individual case management.[9]

Veterinary students are typically expected to read textbooks and learn from the experts how to make decisions and what treatment to use.[10] The aim of training in EBVM is to impart the skills needed to choose the best therapy for patients through rational decision making supported by sound clinical reasoning, scientific evidence, and an understanding of risk management. The extent to which EBVM and critical appraisal of information are included in the veterinary schools' curricula is unknown.

In human medicine, systematic reviews and meta-analyses have been published that address a broad variety of research fields. Furthermore, critically appraised topics (CATs) have been developed that have a more direct relevance to clinicians.[11] A CAT is a standardized summary of research evidence regarding a clinical question[12] generated from a specific patient situation or problem.[11] It is a document of one to three pages that includes a clinical conclusion that reflects a synthesis of one or more research articles and clinical application of the results.[13] The synthesis includes a critique of the internal, external, and statistical validity of research.[14] A CAT differs essentially from traditional systematic research reviews,[15] as shown in Table 1. In human medicine, specific Web sites have been developed for preparation and posting of CATs.[13] To date, even though reviews and meta-analyses are gaining popularity in veterinary medicine, no veterinary CAT databases have been established.[2]

Our objective in this study was to test a concept of team-based development of CATs for training in EBVM. We wanted to test the applicability (i.e., are the students able to develop CATs?) and acceptance of this approach.

MATERIAL AND METHODS

From December 2010 to August 2011, 141 veterinary medicine students in their fifth year at the Freie Universität in Berlin, Germany, were enrolled into the project. Eighteen groups of eight to nine participants each attended a two-week clinical rotation at the Clinic for Animal Reproduction. The project was reviewed and approved by the Ethical Commission of the Charité Hospital associated with the Freie Universität Berlin. We obtained informed consent from all participants.

Table 1: Characteristics of systematic reviews of research and critically appraised topics (CATs)

Characteristics	Systematic review	CAT
Goal	Critical, in-depth assessment of research to provide an overview of current research base	Concise and critical summary of best evidence for a specific clinical scenario
Focus	Comprehensive scope of large body of research	Narrowed down to a specific clinical question
Authors	Usually content and methodology experts	Usually clinicians and practitioners
Information search	Exhaustive search	Limited to best and most current information, time-saving strategies
Design	Can be quantitative (meta-analysis)	Brief narrative summary
Potential for bias	Depends on comprehensiveness and transparency of methods	Rather high

* $N = 116$ students (18 groups)

The course schedule contained an initial presentation by one of the authors (SA in most cases; PH occasionally) and a 90-minute discussion concerning EBVM and CATs on the first day of each clinical rotation. In addition, examples of CATs and a literature evaluation form (LEF; see Figure 1) were introduced. The LEF had been evaluated in an earlier article.[16] We documented the CATs developed in the course of this earlier project and provided this list to the students to avoid redundancy. The students were asked to complete these steps in collaborative group work:

1. development of a clinical question, based on a topic of the students' choice using the PICO approach (patient or problem, intervention, comparison intervention, and outcome);[17]
2. searching for relevant literature and documentation of search strategies and results;
3. retrieving the most promising articles, book chapters, or other information from the library or the Internet;
4. providing one article to each student;
5. carefully reading and assessing the quality of the information;
6. assembling and discussing the information; and
7. formulating an answer (conclusion) to the initially formulated question.

Students were asked to organize these steps on their own. Nevertheless, almost every day the instructors offered guidance on any of the steps. Students documented the clinical background of the CAT, the question developed, and data from the literature search, including databases, keywords, and inclusion and exclusion criteria on a CAT documentation form (see Figure 2). In addition, bibliographic details and abstracts of the selected articles, the evaluation results, and the conclusions could be listed. The form was provided as a printed form and as a Microsoft Word document. Students could work on this project after daily courses, and additional time was scheduled on Wednesdays afternoons.

Before clinical rotation in the Clinic for Animal Reproduction, a librarian had presented on and trained students in methods for online and library literature searching via databases for 90 minutes. In addition, the librarians gave support if the students required it.

To assess the quality of the information, the students could use the LEF on a voluntary basis as a supporting tool (see Figure 1). Evaluating the literature with the LEF included three steps. First, the evidence level (meta-analysis, clinical trial, case report, expert opinion or experience) was determined. Second, the students had to evaluate additional quality criteria and agree or disagree with given statements concerning study design, information content, objectivity, and actuality. Finally, the predetermined rating points had to be summed to obtain the overall rating score.

On the last day of the clinical rotation, we performed a concluding discussion and evaluation of the project. Specific quality parameters of the reviewed articles and usefulness of the CAT were discussed. Finally, we distributed a questionnaire to evaluate the project and reevaluate the LEF. This evaluation form presented statements to which students indicated their level of agreement on a five-point Likert scale. Furthermore, the questionnaire contained some questions regarding EBVM in education and experience with reading journal articles. In addition, students could add comments concerning the project.

RESULTS

A total of 18 CATs were developed (see Table 2). Some student groups had difficulties in developing a specific clinical question or reaching an agreement. Groups that had not formulated a question after five days obtained support from one of the authors. In this situation, the instructor took care not to determine a topic but to stimulate a productive discussion. Afterward, the groups quickly agreed on a topic and formulated a question. Most topics related to the field of animal reproduction, neonatology, and udder health (see Table 2). Regarding species, 14 questions were formulated concerning cattle; two, concerning dogs; and one, concerning specific conditions among horses and cats.

The students then took the following steps. An average of 5.9 articles (minimum = 1, maximum = 14, Median = 6) were included in the CATs (see Table 2). The determination of the evidence level was correct in most cases. Nevertheless, the students discussed some articles on which there was disagreement at the debriefing.

Author(s): _____

Title: _____

Reference: _____

Step 1: Evidence Level

Metaanalysis (statistical combination of the results of several studies)	☐	5 points
Clinical Trial	☐	3 points
Case Report	☐	2 points
Expert's opinion or experience	☐	1 point

Step 2: Additional quality criteria (regarding the corresponding evidence level)

→ Metaanalysis	agree	
The literature search was exhaustive and reproducible	☐	2 points
The included trials were comparable form a clinical point of view	☐	4 points
Trials of a high quality (randomised, controlled, blinded, trials) were included	☐	2 points
Results are discussed objectively and critically including questions regarding comparability and publication bias	☐	2 points

→ Clinical trial	agree	
The trial comprised a sufficient number of animals or samples	☐	2 points
Essential information regarding the animals is given: number, breed, age, sex, inclusion criteria, housing, etc.	☐	1 point
The trial comprised an adequate control group	☐	3 points
The trial is randomised	☐	1 point
The trial is blinded	☐	1 point
Examinations and interventions are described in detail. Results are presented completely	☐	1 point
Adequate statistic procedures were used. Data is complete or missing data is documented sufficiently.	☐	1 point
Results are discussed critically	☐	1 point
The bibliography is adequate (extent and up to date)	☐	1 point

→ Case Report	agree	
Essential information regarding the animals is given: number, breed, age, sex, inclusion criteria, housing, etc.	☐	2 points
Examinations and interventions are described in detail.	☐	2 points
Results are discussed critically	☐	2 points
The bibliography is adequate (extent and up to date)	☐	1 point

→ Expert's opinion or experience	agree	
Results are discussed critically	☐	1 point
The bibliography is adequate (extent and up to date)	☐	1 point

Step 3: Summate rating points to obtain the overall rating score ____

Points: 15 - 13 = very good; 12 – 10 = good; 9 - 7 = satisfactory; 6 - 4 = adequate; 3 – 2 = inadequate; 1 = fail

Figure 1: Literature evaluation form (LEF)

Title of the CAT:

Clinical Szenario:

Clinical question:

Literature search

Database	**Keywords**	**No. of articles found**

Inclusion-/Exclusioncriteria:

Paper 1 (Author, Title, Source): Summary: Comments: Rating:

Paper 2 (Author, Title, Source): Summary: Comments: Rating:

Conclusion:

Figure 2: Critically appraised topic (CAT) documentation form

Table 2: Formulated questions, number of papers selected by the students and formulated conclusions in the course of training evidence-based veterinary medicine via developing critically appraised topics*

Clinical question	Number of papers included	Conclusion
What factors promote teat lesions in cattle?	2	Literature only provides case reports or expert opinions. Teats may be traumatized by being stepped on, barbed wire cuts, virus lesions, or mechanical effects of the milking machine.
How to diagnose subclinical bovine endometritis?	6	Ultrasonographic and cytological examinations are suitable. Transrectal palpation does not provide good results.
What is the most successful prophylaxis of hypocalcemia in dairy cattle?	6	Calcium borogluconate postpartum and Vitamin D3 antepartum were effective in preventing hypocalcemia.
Is PGF 2*α* effective in the treatment of chronic bovine endometritis?	8	All 8 articles support efficacy of PGF 2*α*.
How accurate are different methods for measuring b-hydroxybutyrate in cattle?	7	Measurement in blood and milk provides good results; levels in urine vary. New handheld meters offer quick and reliable data.
Can cystic ovarian disease in cattle be treated using hormonal synchronizing programs?	1	Literature provides only one old study with doubtful quality.
What surgical procedure is the best for left displaced abomasum in cattle?	8	Most authors recommend surgical procedure from the left flank and omentopexia. Surgical procedure should be chosen according to the vet's skills.
How to reduce equine twin pregnancies concerning best prognosis of survival of the remaining embryo?	10	Manual crushing of one embryo is recommended before day 30 of pregnancy. Recently, new techniques have been developed that may lead to modified recommendations in future.
Are additional treatments in the course of antibiotic treatment of acute puerperal metritis in cattle beneficial?	7	Systemic antibiotics are effective. As additional treatments NSAIDs seem not to be beneficial. PGF2*α* may support the therapy.
Do NSAIDs cause ulcers in the stomach of cattle?	2	No valid information available to answer the question.
Does pain management during the castration have positive effects on calves?	7	Pain management has a positive effect and is recommended.
Does comfort of lying affect udder blood flow or milk yield in cattle?	5	According to the 5 studies, more comfort leads to higher milk yield. Authors of two studies explain this as a result of higher blood flow.
Are deslorelin implants safe and effective for estrus prevention in bitches?	14	Implants are effective but can cause severe side effects.
Do B vitamins have a beneficial effect on liver diseases in cattle?	5	Literature (old and of low quality) does not provide sufficient data to support an overall conclusion.
Are permethrin and imidacloprid more effective than fipronil and s-methoprene in controlling ticks in dogs?	7	6 papers vs. 1 paper state a higher efficacy of permethrin and imiclopramid.
How should an ovarian remnant syndrome in the queen be treated?	5	Only case reports or case series available; surgical excision is recommended.
How sensitive is transrectal palpation on day 35 for pregnancy diagnosis in cattle?	3	Transrectal pregnancy diagnosis is highly sensitive and recommended between day 35 and day 42.
How much milk should a newborn calf be fed?	3	The papers are not of high quality and recommend 6 l per day. Recently, it has been discussed whether that is really enough.

PGF 2*α* = prostaglandin F2*α*; NSAIDs = non-steroidal anti-inflammatory drugs
* *N* = 116 students (18 groups)

Table 3: Results of the evaluation of training evidence-based veterinary medicine via developing critically appraised topics*

Statement	Totally agree	Agree	Neutral	Disagree	Totally disagree
Development of CATs is an effective exercise for assessing the quality of scientific literature.	32	64	18	2	0
A compilation of CATs provides a good information source for students.	16	71	23	6	0
A compilation of CATs provides a good information source for veterinary practitioners.	23	55	35	3	0
Using the LEF evaluation is more objective	40	58	16	2	0
By using the LEF, I assessed criteria that I would have not considered otherwise.	26	56	26	7	1
Using the LEF facilitates the consideration whether information should be integrated into practice or not.†	9	63	32	11	0
Considering the quality of scientific information is important.	56	49	10	1	0
Critical appraisal of information should be adequately trained in veterinary education.	37	68	9	1	1

* $N = 116$. CAT = critically appraised topic; LEF = literature evaluation form
† This question was not answered by one student.

Of 141 enrolled students, 116 participated in the debriefing. The missing 25 students were either on farm visits in the course of the clinical rotation or ill. All 116 students completed the evaluation questionnaires.

Of the students, 96 (82.8%) agreed or strongly agreed with the statement that the development of CATs was an effective exercise for assessing the quality of scientific literature (see Table 3). Moreover, 87 (75.0%) students considered CATS to be a good information source for students, and 88 (75.9%) students considered them to be a good information source for veterinary practitioners.

Ninety-eight (84.5%) students agreed or strongly agreed with the statement that the LEF makes the evaluation of scientific articles more objective. Moreover, 84 (72.4%) students agreed or strongly agreed that they had considered additional criteria by using the LEF. Seventy-two students (62.1%) agreed or strongly agreed with the statement that the LEF facilitated the decision of whether the information presented should be implemented into practice.

Regarding veterinary education, 105 (90.5%) students agreed or strongly agreed with the statement that considering the quality of scientific information is important (see Table 3). Training in critical appraisal of information in veterinary education was endorsed by 105 (90.5%) students.

The number of journal articles the participants had read in the past ranged from more than 10 (37 students; 32.0%), between five and 10 (29 students; 25.0%), to fewer than five (49 students; 42.2%). One student stated that he or she had never read an original journal paper.

Additional comments were provided by 28 students. Six students considered training in EBVM very useful. Another six participants stated the project was good or useful, and one student considered it useless. Four students suggested a list of possible clinical topics provided by the course instructors to simplify the development of a clinical question. Four students reported difficulties in literature search and retrieval, and two students complained about additional training time. Three students expressed concerns about the quality of the CATS because they were developed by students and not by experts in the field. Finally, two students considered CATs too specific for clinical education.

DISCUSSION

Veterinary practitioners and clinicians regularly have to make decisions concerning diagnostic procedures and therapeutic interventions in daily practice. In addition, lifelong self-directed learning is required.[13] One necessary element is a routine, thorough search of the veterinary literature to maintain the level of expertise and knowledge required for competence in any field of veterinary medicine.[5] Relying only on review-oriented sources such as textbooks and personal contacts is almost certain to result in missing many new relevant publications.[5] In addition, review articles may be obsolete or biased by methodological flaws.[18] Hence, patient-centered papers presenting recent clinical research findings are most relevant.[13] To be able to handle specific conditions according to the principles of EBVM, the veterinarian needs skills in asking answerable questions and finding the best evidence to answer questions.[19]

This study's results suggest that students are able to develop CATs using a team-based approach. Aside from an introduction to the basics of EBVM and CATs, instructors needed to offer little help. The most frequent problem students faced was finding an answerable clinical question. This observation supports the findings of Head and Eisenberg,[20] and the problem may be the result of a lack of training in formulating such questions or the lack of an overview on a clinical situation. More case-based learning could be an approach to training in these skills.

Because the students had just passed the clinical rotation at the Clinic for Ruminants and also had contact with

cattle at the Clinic for Animal Reproduction, most questions were related to bovine medicine. In addition, real-life clinical questions concerning animal reproduction during the first days of this project obviously stimulated the choice of related questions.

Searches were mainly conducted with two databases: Medline, accessed via PubMed (www.ncbi.nlm.nih.gov/pubmed/), and the Veterinary Science Database (VetCD; accessed via www.ovid.com). Most students reported that literature search and retrieval were possible with moderate effort. Seven groups, though, required and obtained help from librarians.

Students perceived the LEF as a useful tool for systematically summarizing the quality of a publication. However, the user should have a general comprehension of study designs and statistical analysis. In addition, we do not claim that the LEF covers all aspects of validity.

All groups successfully retrieved and assessed information and formulated a conclusion. Nevertheless, three groups postulated a lack of evidence, resulting in a conclusion that did not support a clear decision. Such results may reflect students' insufficient search skills or lack of science-based knowledge. Therefore, a conclusion indicating a lack of evidence can also be considered an objective result. Nevertheless, during the concluding discussion, some students expressed that they were not confident with this "negative" result. Therefore, for training purposes, it may be advantageous to provide topics for which sufficient data are available to avoid CATs with unanswerable questions. However, students need to understand that good evidence may not be available for all decisions they will make in practice. At the debriefing, we had much discussion concerning how to handle such cases.

Three students expressed concerns with the quality of the CATs. Because the CATs were indeed developed by students and not by experts in the field, the actual knowledge contained in them may not be comprehensive, and the quality of the formulated conclusion may not be definite. The objective of our project, however, was to train students, not to produce high-quality CATs. Nevertheless, CATs have to be peer reviewed before publication in CAT databases. Another possibility would be a public review process similar to the concept of Wiki systems.

Comparing our project with that introduced by Hardin and Robertson,[2] several similarities are apparent. Both projects consist of initial lectures presenting the principles of EBVM and CATs. In Hardin and Robertson's[2] project, 72 first-year students had to develop a CAT on their own on a topic of their own choice. They were then guided by instructors over a time period of two months, with a deadline for each step (i.e., project outline, question and article list, appraisal of at least four articles; complete CAT). As a final task, each student was asked to review and comment anonymously on two classmates' final CAT. Each step was worth a certain number of points.

The project presented in this article was conducted by fifth-year veterinary students. Ideally, courses introducing EBVM should be taught in the first semester of the veterinary curriculum. This recommendation was supported by 90% of the students who participated in our trial ($N = 116$). Nevertheless, training in defining a clinical problem, formulating a question, retrieving information, and critical thinking in the course of the development of CATs may be more effective with students in higher years. Students with more clinical expertise may better comprehend the clinical background and importance of the literature on clinical decision making. In addition, all 18 groups chose a topic that related to recently experienced or discussed problems during the previous weeks' clinical rotations. One can assume that this direct relationship to real-life situations also stimulated an intrinsic interest in retrieving information and formulating an applicable conclusion.

Preparing a CAT in a team-based approach did stimulate discussion on the topic and on the quality of the retrieved papers. If every student had had to develop a CAT, the given time frame of two weeks would have been too short and the efforts required of each student would have been too high. Most students (82.8%) considered the development of CATs to be an effective exercise in assessing the quality of scientific literature. In addition, most students (90.5%) agreed or strongly agreed with the statement that considering the quality of scientific information is important (see Table 3). Training in critical appraisal of information in veterinary education was endorsed by 105 students (90.5%).

The compilation of CATs as an information source for students and veterinary practitioners was supported by 75.0% (87) of the students. Therefore, we conceptualize the implementation of an online veterinary database that enables collaborative development and subsequent modification of CATs. Such a database would allow students to access examples and enter their own CATs and would provide more sophisticated search strategies.[2] One reason that veterinary CAT databases have not yet been developed may be the perceived lack of high-quality, patient-centered publications available to veterinarians.[2] The reason why CATs are rarely used in veterinary education and practice may be because they are still widely unknown.

Only 57.0% (66) of the students stated that they had read more than five scientific articles. This percentage is less than that found in a previous study, in which 70.5% stated they had read more than five scientific articles.[16] These results indicate that more original articles from scientific journals should be integrated into clinical education.

In conclusion, the concept of team-based development of CATs during clinical rotations is highly valuable for training in EBVM because all groups were able to develop CATs. Learning is enhanced by creating a situation similar to veterinary practice because the task is embedded into an authentic clinical problem. Several cognitive procedures and different knowledge dimensions are involved in the learning process.[2] The students showed that they were able to find, retrieve, appraise, and interpret the results of published scientific studies. Furthermore, all groups discussed disagreement on the applicability and quality parameters of distinct articles. The LEF provides an effective tool to assess the quality of retrieved information. This approach to clinical training helps to prepare students to integrate evidence from the literature into practice.

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