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Special Topic Overview

Biomedical Journals: Keeping Up and Reading Critically

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By extrapolation from studies of physicians, knowledge and practice of laboratory animal medicine and science are expected to become progressively more outdated the longer practitioners are out of school. Keeping up with current literature and practice is a challenge that necessitates the use of many different sources of continuing education. Both veterinarians and physicians consistently list journals as the most beneficial source of new information. Accordingly, they must select from the veterinary and biomedical literature articles that report original studies and systematic reviews and recognize and respond to valid new knowledge to improve diagnostic and therapeutic approaches and maintain consistent clinical skills. Other objectives include selecting journals for general information and for information relevant or specific to one's field of research. Lastly, candidates for board certification need to read articles from journals that potentially provide the basis for questions on the examination. 'High-impact' journals should be identified, and articles should be reviewed critically. In a survey of recent candidates for laboratory animal medicine board examination, these journals included *Contemporary Topics* (now *JAALAS*), *Comparative Medicine*, *ILAR Journal*, and *Laboratory Animals*. Strategies for coping with the challenge of staying current with the literature include wise use of technology, journal clubs, and consultation with colleagues. A laboratory animal practitioner can become a better scientist and clinician by evaluating the research performed by others. Thorough, critical review of biomedical literature is paramount to these goals.

Abbreviations: ACLAM, American College of Laboratory Animal Medicine

Although several articles in the medical literature have addressed the issue of staying abreast of the literature, none focus on veterinary medicine or the specialty of laboratory animal medicine.[10,15-20,23] Studies of physicians have found that their knowledge and practice grows progressively more outdated the longer they are out of school, and by extrapolation, the same can be expected of laboratory animal practitioners.[15,21] According to Haynes and coworkers,[15] "There is a need to recognize and respond to new diagnostic and therapeutic approaches so that one's clinical skills remain consistent with valid new knowledge." To stay current with techniques, trends and information, a laboratory animal practitioner needs to identify useful continuing education resources. Both veterinarians and physicians consistently list journals as their primary method of keeping up to date.[15,27] Accordingly, the initial objective is to select journals that have 'high impact' and to give high priority to peer-reviewed, original articles that use study designs that are most likely to give valid results. Because laboratory animal practitioners are not only clinicians but also researchers and consultants, other objectives should be addressed, including selecting journals for general science information and key journals in one's field of research. Reading for certification or preparing for the American College of Laboratory Animal Medicine (ACLAM) certification exam may also be an important goal. Literature review also may contribute to ACLAM recertification and is an important part of continuing education.

The final step in staying current with the literature includes learning to read critically and evaluate the importance of the newly gained information. No one can reasonably expect to review all the biomedical literature that is published yearly, but with certain tools, one can filter the information into a manageable quantity. In this paper, we address the techniques necessary to stay current with the biomedical literature and critically evaluate articles.

Reading the Biomedical Literature

Studies show that older physicians are less likely to use new technologies, preferring the same technologies and modalities that they were taught during didactic portions of their training.[10,15] Like physicians and other practicing veterinarians, laboratory animal practitioners must incorporate emerging concepts, technologies, and modalities into clinical practice to remain competent. New pharmaceuticals and surgical techniques must be evaluated for their efficacy and cost-effectiveness, and new knowledge on emerging diseases, existing infectious agents, and the pathobiology of diseases should be integrated. In contrast to physicians and other practicing veterinarians, laboratory animal practitioners also need to stay current with new research technologies, animal models, and animal care and use guidelines. For those practitioners involved in biomedical research, staying current with one's field of interest is another necessity. Lastly, laboratory animal practitioners should keep up with current professional topics and trends in general science and biotechnology that may signal future changes in this field.

A survey of 270 veterinarians[27] showed that for 'keeping up

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Table 1. Journals recommended for use in preparing for the ACLAM certifying examination

Primary journals	Secondary journals
Laboratory Animal Science (as of 2000, this journal is *Comparative Medicine*)	*Laboratory Animals*
Contemporary Topics in Laboratory Animal Science (as of 2006, this journal is *Journal of the American Association for Laboratory Animal Science*)	*American Journal of Veterinary Research*
ILAR Journal	*Science*
Veterinary Pathology	*Nature*
Journal of the American Veterinary Medical Association	*Journal of Medical Primatology*

Adapted from http://www.aclam.org/cert_exam.html.

to date' on current trends and practices within their related fields, journals were the most important source of information, a finding that is consistent with similar surveys of physicians.[9,31] However, the amount of literature on laboratory animals available for review is overwhelming. Assuming that the time available to veterinarians is similar to the average amount of weekly journal reading time reported on physician surveys (that is, 3 h),[15] then the more selective one can be with effective use of available technology and other tools, the more successful one can be in coping with the challenge. What can you do to make the most of your time? You can start by selecting high-impact journals and relevant articles that are applicable and of sound scientific merit. Efficient use of technology can aid this process, whereas the ability to critically evaluate the literature will aid in the assimilation of information.

Selecting high-impact journals. A study of small animal practitioners, based on an analysis of journal citations, revealed that practitioners were able to keep current with information on diseases by regularly reviewing 5 key veterinary journals covering their specialty.[27] Therefore, the goal is to identify the key journals covering the specialty of laboratory animal medicine and science. Because journals can vary dramatically in quality, content, and diversity of topics, a first step is to identify and review journals that contain a large amount of information pertinent to one's interests (that is, high-impact journals).

Various journals are recommended in preparing for the ACLAM certifying examination (Table 1).[5] These journals cover a broad variety of topics relevant to clinical practice, as well as animal care and use and animal models of human diseases. Also included are 2 journals useful for staying current on general interest topics and professional trends (that is, *Science, Nature*). Articles focused on contemporary topics may also be found outside the journal format (for example, *The New York Times*). The ACLAM-recommended list does not address basic research interests. Many laboratory animal practitioners have clinical responsibilities while concurrently performing basic or applied biomedical research; therefore, the selection of journals should be tailored to their specific research interests and clinical practice.

After selecting journals of high impact, one should rank the journals. The most important journals should be reviewed first, whereas secondary journals are of lesser priority. Cost may be a barrier to accessing the literature, but one needs to invest in journals that are worth the time. Consider splitting the cost of starting a library of high-impact journals with colleagues or use library services to select individual articles. The effective use of technology to identify and store these materials is discussed later.

Selecting relevant articles. Because the scope of the laboratory animal practitioner may bridge several species and fields of knowledge (that is, animal care and use, vivarium design), covering all articles in the key journals is not an efficient practice. Within each journal, one should select articles of importance and give highest priority to original journal articles (new investigative reports, in contrast to review articles) that also give a strong foundation for the practice of evidence-based medicine. Evidence-based medicine is the foundation for another method of literature review, mainly for clinical information, in which one searches the literature to answer specific questions. The foundation of this information comes from original journal articles. Several databases, such as the Cochrane Collaboration, have sets of systematic reviews or abstracts that are organized to help answer specific clinical questions.[14] Literature reviews organized around evidence-based medicine can be adapted for life-long learning by formulating specific questions from information needs and searching routinely for the evidence in support of current practices.

In most surveys of physicians, the most widely read articles are editorials and reviews.[24] Although editorials and reviews may be easier and more entertaining to read, original research articles are the most current source of information, especially for the practice of evidence-based medicine. Systematic review articles serve a useful purpose in biomedical literature and can be important references, but they are generally less current than original research articles.[15] However, review articles may inform the reader of important original articles. Other types of articles, such as opinions, editorials, technology updates and case reports, should be reviewed as appropriate with consideration to the applicability of each topic. Editorials are important sources of current opinion and developments in the field but are not generally peer-reviewed. Unfortunately, the veterinary literature has a paucity of original studies, due to financial constraints and other limitations.[25] Hopefully, in coming years, there will be increased funding for veterinary-related topics and editors will continue to encourage submission of original research articles.

Peer review is also an important factor in selecting journals and articles for review. A study of physicians showed that many of the journals and articles read were not peer-reviewed, that is, they had arrived unsolicited in the mail or from sponsored commercial interests.[31] In comparison, articles in peer-reviewed journals are more likely to contain valid, unbiased information that will be relevant and useful in practice. Most journal articles that are original publications (that is, not review articles) are peer-reviewed. The selection of peer-reviewed literature is important in raising the effectiveness of literature review and keeping up-to-date with current topics. Emphasis should be placed on peer-reviewed journals and articles in the selection of topics for review. However, the process of peer-review is imperfect, and one needs to personally review each article critically.[24] One should always consider the possibility of bias in the study.[33] Therefore, journals that require authors to disclose conflicts of interest are preferred.

Although this article stresses the use of peer-reviewed, original research articles for the most current information, we also stress that attendance at professional conferences and meetings occasionally offers more timely evaluation of current informa-

Table 2. Study designs used for the comparison of groups[a]

Study design	Temporal nature	Characterization of subjects at enrollment	Measures of association
Ecological	point or period in time	units of analysis are groups or populations and not individuals	correlation, odds ratio, or relative risk (see below)
Cross-sectional or prevalence	point or period in time; may collect retrospective data	exposure and disease status determined as of the same time	prevalence ratio = no. exposed with disease/total no. exposed/no. unexposed with disease/total no. unexposed
Case-control	collect retrospective data on exposures	diseased (cases) and nondiseased (controls)	odds ratio = no. exposed with disease/no. unexposed with disease/no. exposed without disease/no. unexposed without disease
Cohort	follow participants over time; collect retrospective or prospective (concurrent) data on diseases	exposed and unexposed	relative risk = no. exposed with disease/total no. exposed/no. unexposed with disease/total no. unexposed
Randomized clinical trial	follow participants over time	usually either all diseased (if study is disease outcome) or all nondiseased but at risk; randomly assigned to an exposure status (treatment)	relative risk = no. with disease and treated/total no. treated/no. with disease and untreated/total no. untreated relative risk = incidence rate among treated/incidence rate among untreated

Adapted from Nelson K, Williams C, Graham N. 2001. Infectious disease epidemiology. Theory and practice. Gaithersburg (MD): Aspen Publishers. p 61.

Table 3. Design of studies published in various laboratory animal journals for 2002 through 2004

Journal	Review[a]	Models[b]	Randomized clinical trial[c]	Methods[d]	Applied or basic biology[e]	Case or case series[f]	Diagnostic testing[g]	Other[h]	Total
Comparative Medicine	22 (16)	12 (9)	21 (15.3)	7 (5)	13 (9.5)	28 (20.4)	10 (7.3)	24 (17.5)	137 (100)
Contemporary Topics	2 (1.5)	2 (1.5)	43 (30.5)	51 (36)	6 (4)	17 (12)	2 (1.5)	18 (13)	141 (100)
Laboratory Animals	10 (8)	5 (4)	42 (34)	20 (16)	11 (9)	8 (6.5)	3 (2.5)	25 (20)	124 (100)

Data are presented as the number of articles in which the study design was used (percentage of all articles)
[a]Metareview and systematic review articles.
[b]Description or characterization of an animal model of disease.
[c]Study in which randomization and blinding were used (where applicable) in a trial of one or more treatments.
[d]Descriptive study of a methodology that did not compare groups.
[e]Descriptive or observational study of disease or basic biologic process. Included cross-sectional, case-control studies and cohort studies.
[f]Report of a single or series of cases.
[g]Description of a diagnostic test procedure that did not compare groups.
[h]Any article that did not fall into one of the other groups (for example, editorials, opinions, articles with multiple study designs, nonrandomized controlled trials).

tion, as the results presented at these meetings often are not yet published. These forums also provide an opportunity to directly question the authors or other specialty colleagues to gain a better understanding of the material presented in recent articles and to discuss the potential role of new tests, drugs, or interventions.[29]

Assessing the type of study design is one strategy for selecting journal articles to read. For example, if the purpose of the article is the evaluation of a treatment, a randomized clinical (controlled) trial is preferred, as the results likely are more reliable than those from other types of study design. Table 2 lists the common types of study designs for the comparison of groups and the features of these studies. In a personal review of articles in *Comparative Medicine*, *Contemporary Topics*, and *Laboratory Animals* (Table 3) over the past 3 y, the most common type of study design used in articles was the randomized clinical trial. These journals also contained articles that were observational or descriptive. Selecting articles that use an appropriate study design (for example, comparing a new treatment to the accepted standard in a treatment trial) is the most efficient use of time in journal review. Often, it is difficult to determine the actual study design from the abstract and article content, and editors should require clear identification of the study design in the manuscript. After one has reviewed and identified high-impact journals and relevant articles, a fraction of the articles will be left for critical review.

Technology. Many laboratory animal practitioners benefit from close proximity to information resources. Medical libraries at many health sciences schools as well as research centers hold exhaustive collections of veterinary medical journals. Libraries are an important resource for journals as well as other continuing education materials. For practitioners not located close to a major medical center, a nearby school or hospital library may be useful. Trained librarians are able to efficiently search for relevant topics and assist practitioners in the retrieval of high-impact journals and articles. In addition, many online search

Table 4. Comparison of literature search services

Email service	Databases searched	Coverage	Email format(s)	Search frequency	No. of searches per account	User-friendly search screen?	Preferred search times?	Related articles?[a]	Results sent as webpage?	Response to 0 results?
My NCBI	PubMed	Biomedical and health journals	HTML or text	Daily, weekly, or monthly	Unlimited	Yes	No	Yes	No	User's choice
OVID AutoAlerts	CINAHL, ERIC, PsycINFO, and others	Varies depending on database	Text, text with links, HTML	Varies	Unlimited	Yes	No	No	No	Notified
Cambridge Scientific Abstracts (CSA)	NTIS, PAIS, Sociological Abstracts, and others	Varies depending on database	Text or text with links	Weekly	50 (for ≤6 mo)	Yes	No	No	No	Not notified
Web of Knowledge	Current Contents, Web of Science, BIOSYS	>8000 scholarly journals, >2000 books, and >4000 websites	HTML or text	Weekly	Unlimited	Yes	No	Yes, with HTML results and citing articles	No	Notified
ScienceDirect	ScienceDirect journals	>1800 science, technology, and medical titles	Text	Daily, weekly, or monthly	10	Yes; pull-down menus of search fields	No	Yes, to citing articles	Email link to webpage	Not notified
WebSPRIS	AGRICOLA and others	Varies depending on database	Text with links	Varies	Unlimited	Yes	Varies	No	No	User's choice

[a]Related articles are those that contain information similar to the articles identified in the original search.
Adapted from http://healthlinks.washington.edu/howto/alerts.html

Table 5. Frequency of serious arithmetic and reporting problems in biomedical manuscripts

Section	Problem	%
Abstract	Discrepancy between hypothesis or conclusions in abstract and text	31
	Discrepancy between data in abstract and text	31
Introduction	Hypothesis or question missing or described differently in different sections	38
Materials and Methods	Alpha level for *P* values not reported	47
	Whether test was one- or two-sided not reported	63
Results	Arithmetic error or discrepancy	66
	Non-normally distributed data treated as normally distributed data	44
Discussion	Limitations of study missing	47

Adapted from J Am Med Writers Assoc **15:**24-27. Based on 32 manuscripts.

engines are useful in the selection of literature. As investigators are expected to conduct thorough literature searches to justify animal care and use protocols, it is crucial for laboratory animal practitioners to be familiar with a variety of online literature search engines.

In addition to subscribing to high-priority journals or using library services, a variety of email alert services are available. These services can help identify articles of importance in journals that are not frequently reviewed. For example, using a 'selective dissemination of information' service or a program such as My NCBI can facilitate filtering articles of importance on specific topics and provide periodic email updates. A second example is *ISI Current Contents*, which allows one to easily browse for articles through titles of interest in tables of contents in secondary journals. The librarians at the University of Washington (Health Sciences Libraries, University of Washington-Seattle, Seattle, WA) prepared an online list comparing the features of eight email alert services (Table 4).[11] After the appropriate index terms (see a librarian for assistance if necessary) are selected, these services can provide periodic updates with articles of interest. For example, *Helicobacter* and specific pathogen-free techniques can be requested in an effort to develop procedures for exclusion of this pathogen from a facility.

Text mining is another technique being developed to assist researchers extract specific, useful information from biomedical articles. These software programs may aid readers by scanning abstracts and full-length papers, pulling out essential information and storing it for review.[8] Metasearch engines, which concurrently search multiple databases, are being developed and applied to the biomedical literature.[7] These programs may be more widely available in the near future.

One can keep track of articles and avoid duplication by using a variety of storage methods. The filing system used will depend on the sources of your articles and how you use your archives, but there are several options for citation storage. Citations generated by email alert services or personal reading can be stored for later retrieval by any of several methods. Several software programs can store citations as well as abstracts and arrange references for a manuscript in a variety of different formats.

Journal clubs. Journal clubs are another resource for keeping up with biomedical and clinical journals. The Laboratory Animal Boards Study Group[22] is an organized online resource for keeping up with current articles. Although this online resource primarily is oriented to practitioners studying for the ACLAM certifying examination, it may provide an impetus for others to start reviewing the current journals. This online study group provides summaries of recent journal articles from several laboratory animal and general biomedical journals. These summaries should supplement, and not replace, personal review of the original articles. Academic, institutional, and email journal clubs are another set of resources for the laboratory animal practitioner. Reviewing articles in groups may provide incentive to remain current with the literature. Group review and discussion also can be helpful in the critical review of each article and assist in integrating and implementing new information through active learning. The difficulty with journal clubs is maintaining attendance. The provision of food and mandatory attendance were helpful in maintaining journal clubs in medical residencies.[30,32]

There is no formal Laboratory Animal Science Study Group associated with a professional organization or society other than the one specifically designed for laboratory animal practitioners preparing for the ACLAM certifying exam. However, other professional organizations do have excellent journal clubs (that is, American College of Physicians Journal Club[2]) that allow for formal review of individual articles. These professional journal clubs may be a template for the establishment of a Laboratory Animal Science Journal Club in the future.

Review

Once high-impact, applicable, scientifically sound literature has been identified, one still needs to review the articles critically. Serious problems in biomedical articles have been frequently documented (Table 5).[1,3,4,6,13,28,34] Therefore, critical evaluation of articles is required to give the reader a better ability to integrate the information into practice.

Although critical reading skills develop over time, we consider that a simple outline can be followed to systematically evaluate a paper or prepare an article for publication (Table 6). Critical review addresses each section of the article and requires the reader to evaluate more than the introduction, discussion, or conclusions. A critical reader thoughtfully reviews the integrity and applicability of the article as well as the relationship of the information or concepts with current knowledge. The following questions are especially relevant to the review of randomized controlled trials using animal models.

The Introduction should address why the study was done. What was the hypothesis, question, objective, or purpose? The Materials and Methods section should address what was done. If the methods appear incomplete or unclear, keep that in mind when reviewing the rest of the article. The Results section should address what was found. Questions to consider include: Was there consistency between the methods used and the results reported? Were all animals accounted for? If differences between groups were detected, could they be due to a lack

Table 6. Evaluation of biomedical literature

Title	• Succinctly and unambiguously (specific) describes the subject of the study.
Abstract (Summary)	• Provides the following information, in this order: background and purpose (or objective, hypothesis), methods (kinds and numbers of animals and experimental design), results, and conclusions.
Introduction (Why was study done?)	• Adequately states why the study was done (purpose, objective, question or hypothesis).
Materials and Methods (What was done?)	• Animals described sufficiently (source, species, strain, sex, age, weight). • Animals appropriately conditioned or acclimated prior to experimentation. • Housing conditions (caging, bedding, feed, water) described sufficiently. • Environmental conditions (temperature, humidity, light cycle, air changes, and pressure) described sufficiently. • Microbiologic status of animals described. • Names of products or equipment and their manufacturers, including address (city and state), provided. • Approval of animal studies by an institutional animal care and use (or similar) committee indicated. • Studies conducted humanely. • Experimental design features: – Explanation of how the number of animals used was determined is provided. – Rationale for the study design provided. – Random assignment—indication of use of a formal method to ensure randomization rather than haphazard selection. – Control group(s) the same as experimental group(s) except for variable being tested. – Sufficient description of placebos, sham procedures, or alternative treatments received by control group. – Individual(s) evaluating outcome unaware of (blinded to) groups to which subjects assigned. If there are multiple evaluators, reconciliation of differences in evaluation are explained. Need for training to evaluate data is specified. – In studies linking an infectious agent to a disease syndrome, all other agents that can cause such a syndrome have been accounted for. – In studies in which infectious agents are inoculated, animals are free of the inoculating agent according to appropriate tests. – Levels of severity defined and basis for definition provided (for example, mean and standard deviation). • Methods presented in sufficient detail to permit replication. • Statistical analyses: – Parameters of estimation (confidence interval) used rather than hypothesis testing (*P* value). – Comparison(s) made and the statistical procedure(s) used to make them are described. – Parametric tests used for normally distributed data; non-parametric tests used for non-normally distributed data. – Tests are indicated as being one- or two-tailed. – Alpha level indicated for *P* values. – Tests are referenced
Results (What was found?)	• Internally consistent—results presented for all methods described, and methods presented for all results described. • All animals are accounted for. • Statistical analyses: – Normally distributed data presented as mean, SD and range. Non-normally distributed data presented as median and interquartile (25th–75th quartile) range. – Adjustment or control for confounding performed if indicated. The test statistic, degrees of freedom and exact *P* value given. – When data are pooled, ensure that it has been statistically compared beforehand. – If no significant difference found, was sample size adequate to detect a difference? • Quantitative data converted to qualitative data? • Data in text more appropriately presented as figure or table?
Discussion (What does it mean?)	• Limitations of the study are described. • Conclusions are supported by the data. • Sufficiently describes the importance, significance, implications, and generalizability of findings. • Adequately puts findings in the context of previously published studies.
References	• Current • Appropriate
Figures and tables	• Is figure or table necessary, or could data have been presented in the text just as well? • All animals are accounted for. • Data summarized rather than presented as individual values.

of comparability rather than the experimental treatment? The Discussion or Conclusion section should address the meaning and importance of the study. Were the conclusions drawn from the findings justified? Were the strengths and weaknesses of the study acknowledged? Does the Discussion place the findings in the context of previously published studies?

Critical review of biomedical literature gives the laboratory animal practitioner the ability to incorporate valid and important concepts that apply to one's area of research or clinical practice. Critical review also includes assessing whether the study population reflects one's own patient or subject profile, and therefore, is applicable to one's practice.

Reading for the ACLAM Exam

Reading in preparation for an examination requires different reading techniques than those for keeping up to date. The key journals for review may be slightly different than those chosen for routine review outside of the preparation period. As indicated previously, there are both primary and secondary journals recommended by ACLAM in preparation for the exam. In a recent survey (2004) of 42 veterinarians who took the ACLAM examination, the key journals identified included *Comparative Medicine, Contemporary Topics, ILAR Journal*, and *Laboratory Animals*.[12] *Comparative Medicine* and *Contemporary Topics* appeared to be valued more highly than other journals. Journals of lesser importance were the *Journal of the American Veterinary Medical Association*, *Nature*, and *Science*, as well as *Mammalian Genome* and *Proceedings of the National Academy of Sciences*, which were not on the list of ACLAM-recommended journals. The last 2 journals each were listed by only a single respondent and may have been included due to individual need for knowledge in particular areas.

In general, the amount of time dedicated to reviewing these journals exceeds the average time used for routine reading. On average, 1100 h were spent studying for the exam, including books, study notes, and so forth.[12] The time allocated to review of each journal may be based on an understanding of concepts involved in the articles and the perceived value of that journal. The following statement from the ACLAM webpage raises another factor to consider when selecting articles to read. "On both examinations, the percentage of questions is balanced on 2 factors: the Role Delineation Document tasks and the species of animal."[5]

In our opinion, for the exam, one must remember the details of the Introduction, Materials and Methods, Results, and Conclusions as well as the content of any tables or figures. This process is independent of whether one agrees with the conclusions or will be applying the concepts or techniques. Additional time may be needed to understand unfamiliar methods or procedures.

Conclusion

Keeping up with the literature is important in maintaining professional competence in both clinical practice and research. For those active in clinical practice or for those who find themselves in the clinics with decreasing frequency, literature review is critically important in keeping up with the profession. Continuing education requires change as one's career progresses, and subspecialization in the field may require periodic reevaluation of personal literature review needs. Although initially daunting, keeping up with the ever-expanding biomedical literature is manageable by following the steps we outlined in this article. By use of available technology and personal review, high-impact journals can be selected from the biomedical literature. Selecting articles that are applicable and of sound scientific merit will decrease the number of articles for review. Emphasis should be given to the selection of original studies, which are reviewed critically.

Whether informal or formal, journal clubs provide an excellent forum for critical review of literature, as there is a sense of responsibility to others. Moreover, the involvement of several participants lends itself to more informed critical review. Informal journal clubs may be flexible in the variety of articles, discussion styles, and time involved, whereas an online journal club is a forum for summaries of journal articles that are accessible at any time. However, reading the summaries of articles is not a replacement for critical review of the original publication but rather is a supplement for stimulation of thought, a review, or an aid in studying for the ACLAM certification exam.

In the end, however, the journey toward certification should be prized for its intrinsic value as much, if not more than, the achievement of passing the ACLAM boards. Laboratory animal practitioners likely will become better scientists and clinicians when they are able to critically evaluate research performed by others.

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