ARTICLE

The Value of Systematic Reviews as Research Activities in Medical Education

Thomas A. Lang, MA

ABSTRACT

Medical residents and postdoctoral fellows are often required to conduct and publish original research as part of their medical education. However, their relative lack of experience, time, money, and sometimes supervision in conducting original research often results in research of modest quality on topics of limited importance. Such research may also consume scarce resources from the sponsoring institution. Manuscripts describing such research are often unremarkable, although most are submitted for publication, where editors and peer reviewers will spend time evaluating them.

Systematic reviews of the literature, however, offer similar training in the scientific method, are relatively inexpensive to conduct, teach critical appraisal of the literature, give trainees a thorough command of the topic studied, and provide even new investigators the opportunity to make important contributions to the literature. Systematic reviews of the literature should thus be acceptable alternatives to original research assignments for most trainees in medical education programs.

The author reviews the characteristics of systematic reviews, outlines the steps in conducting them, identifies the lessons learned from completing each step, and compares the advantages and disadvantages of systematic reviews with those of conducting original research.

Acad Med. 2004;79:1067–1072.

> The most important obligation now confronting the nation's colleges and universities is to break out of the tired old teaching versus research debate and define, in more creative ways, what it means to be a scholar. —Ernest Boyer, *Scholarship Reconsidered: Priorities of the Professoriate*

As the manager of medical editing services for a tertiary medical, research, and teaching hospital for many years, and now as a consultant and trainer in scientific publications, I have helped hundreds of residents and fellows prepare their research manuscripts for publication. Despite providing trainees with experience in the research and publishing processes, the vast majority of these manuscripts reported research of modest quality on topics of limited importance. Yet, these manuscripts often represented a substantial investment by the institution, as well as by the authors.

Systematic reviews of the literature (defined below) offer trainees the opportunity to address important clinical questions worthy of publication in leading journals. Such reviews can provide trainees with desired experience in the research and publishing processes, usually at reduced costs to the institution, and are consistent with the recommendations of the Boyer Commission on redefining education in research.[1] In addition, they provide trainees with a body of evidence-based knowledge about a topic that they would probably not gain from conducting a single original study with a limited review of the literature.

In this article, then, I make the case that systematic reviews of the literature are not only suitable for meeting most academic research and publication requirements for trainees, but that they also have additional advantages not provided by conducting original research. As such, they should be a legitimate and acceptable alternative to the requirement that residents and fellows perform original research.

Mr. Lang *is principal, Tom Lang Communications and Training, Murphys, California. He was formerly manager, Medical Editing Services, the Cleveland Clinic Foundation, Cleveland, Ohio, and senior scientific writer, Division of Clinical Care Research, Tufts University School of Medicine/New England Medical Center, Boston, Massachusetts.*

Correspondence should be addressed to Mr. Lang, PO Box 1257, Murphys, CA 95247; telephone: 209-728-3057; e-mail: ⟨tomlangcom@aol.com⟩.

THE REQUIREMENT TO PUBLISH ORIGINAL RESEARCH

Many medical education programs require their trainees to complete an original research project by the end of their academic term. (*Original research* is defined here as formulating and testing a unique hypothesis with an observational or, occasionally, an interventional study.) The purpose of these assignments is to train new physicians in critical thinking and in the scientific method, familiarize them with the research and publication processes, and provide them with an experience and perhaps a publication that will further their careers.

Sometimes, trainees contribute to research designed or conducted by a supervising researcher. Other times, they must develop their own research plan. Unfortunately, new researchers seldom have the time, experience, skill, resources, or supervision needed to conceive, plan, initiate, complete, and publish research of real value in the available time. However, in a student version of "publish or perish," trainees must still investigate *something* in the time allowed. This requirement often produces unremarkable research.

The institutional costs of sponsoring and publishing even marginal research can be substantial. Such support may include costs for laboratory tests, clinical supplies, statistical consultations, and so on, as well as hidden costs, such as those for medical records management, institutional review board hearings, departmental oversight, and project accounting. Manuscript preparation may include costs for secretarial time, library services, medical illustrations, and manuscript editing. Few would argue that costly, unremarkable research is a good investment for the institution, especially when published in third- or fourth-tier journals.

CHARACTERISTICS OF SYSTEMATIC REVIEWS

A systematic review of the literature is a systematic, organized, and structured evaluation of a problem using information from a number of independent studies of the problem.[2] These characteristics make systematic reviews different from traditional "narrative" review articles (see below). In addition, systematic reviews are the product of a specific research methodology. Therefore, they teach many of the same principles of scientific inquiry and involve similar design and execution issues as other research methods.

Systematic reviews differ from the more common narrative reviews in several important ways. In a narrative review of the literature, an "expert" selects the articles deemed to be most important, comes to some conclusions about the problem based on these articles (as well as on his or her own experience), and summarizes his or her understanding of the issues in a review article. Thus, a narrative review is neither systematic nor reproducible; different experts may cite different evidence for different reasons and reach different conclusions.

In a systematic review, the articles to be reviewed are identified from a systematic and comprehensive search of the literature and are selected according to criteria set in advance of the study. Data are then systematically abstracted from the reviewed articles, compiled into evidence tables, and then interpreted in the context of all relevant studies. In some circumstances, numerical results can be pooled statistically in a meta-analysis to aid interpretation. A systematic review is a distinct, reproducible research method that involves the same types of scientific effort required of all medical research methods.

ADVANTAGES OF SYSTEMATIC REVIEWS

Research in general follows several common steps. Here, I detail how systematic reviews follow these steps and indicate the lessons learned from completing each step. Where possible, I also describe the unique advantages of systematic reviews over original research. The purpose of this section is not to teach how to conduct a systematic review (for information on that process, see the bibliography at the end of this article), but rather to make the case that they can be—and indeed must be—conducted as rigorously as is any other type of research.

1. *Become interested in a biological or human problem.* Such interest is what draws people to medical science in the first place. The advantage of a systematic review is that the problem can truly be one of interest to the trainee and to the field of medicine and not simply one that can be studied under given time and resource constraints.
2. *Learn what is known about the problem.* This step is completed more thoroughly in a systematic review than in the traditional review of the literature that should precede every research project. In fact, the purpose of a systematic review is to quantify and summarize everything that is known about a specific topic. A unique advantage of systematic reviews is that those who complete them become highly knowledgeable about the topics involved. Such knowledge includes the nature and scope of the problem; the theoretical approaches, research designs, analytical methods, and endpoints most often used to address the problem; and the authors, institutions, and journals most concerned with the problem.
3. *Formulate a research question about the problem.* Systematic reviews, like other research methods, require a

testable hypothesis or a focused research question. The scope and even the feasibility of the review depend on the specific hypothesis or question posed. The difference is that the scope and feasibility of a systematic review can often be assessed with a single literature search, whereas many of the problems in observational or interventional studies may not be apparent until long after the study has begun. For example, a literature search for studies of pet ownership and mental illness would indicate whether there were enough published articles on this topic to conduct a systematic review. In contrast, the effort of directly determining pet ownership among psychiatric patients and matched controls could be considerable, and the feasibility of the study would be not be known until after pet ownership had been determined.

Another advantage of systematic reviews in medical education is that the scope of the research question can be adjusted to fit the learning situation. If the literature on the question is vast, the question can be narrowed or the number of trainees conducting the review can be expanded. After all, research, even a systematic review, is usually collaborative. If the literature on the question is limited, the review can either be completed more quickly or the question can be broadened.

4. *Design an experiment to test one or more possible answers to the question.* Like other good research methods, systematic reviews begin with a clear statement of the relationship to be studied. The scope and feasibility of the proposed review can be determined by exploratory literature searches.

   Identify explanatory and response variables. One lesson learned in many systematic reviews is that literature on a given topic reflects a variety of different explanatory and response variables. This variety can make comparing studies difficult. It should also encourage trainees to include standard explanatory and response variables should they ever conduct their own, original research.

   Choose an experimental design. Systematic reviews, by definition, are observational studies, even though the studies they include may include case–control, survey, cohort, or randomized trials. The review should follow a written protocol prepared before the study is begun, and, as in any research design, systematic reviews require guarding against bias and potential confounding.

   Implement safeguards against bias. Systematic reviews are subject to a number of biases that need to be minimized. *Publication bias* refers to the fact that positive studies are more often found in the literature than are negative or inconclusive studies. *Selection bias* can occur when two or more trainees identify different articles to be retrieved for evaluation or to be included in the review. *Measurement bias* can also occur if trainees abstract different values for the same variables from the same article.

   Control for confounding. As in other research designs, data on potentially confounding variables must be collected from the articles reviewed so that confounding can be identified or minimized in the analysis. A typical lesson of systematic reviews is to illustrate how often the studies reviewed do not report data on potentially confounding variables.

5. *Select a sample to study.* As in any research, sample selection is critical to the quality of a systematic review. The search strategies employed to identify articles are a part of the methodology of the review. Variables may include publication type (case–control studies; randomized trials); dates of publication; language of publication; and populations, interventions, or endpoints of the studies.

   In addition, many systematic reviews are restricted to studies with certain methodological characteristics. For example, a review might include only randomized, placebo-controlled trials enrolling at least 100 patients and having a follow-up period of six months.

6. *Collect the data needed to answer the question.* When trainees begin abstracting information from published articles, they learn quickly how poorly studies are reported in the literature.[3] Trainees will almost certainly learn that titles and abstracts don't always indicate what the article is about. They will encounter studies that do not report the desired information or do not report it in a form easily compared to that in other studies. They may have to calculate "effect sizes" to compare dissimilar units of analysis or to create other ways to compare outcomes.[4]

7. *Analyze and interpret the data, perhaps statistically.* Compiling abstracted data into one or more evidence tables teaches record-keeping and data-management skills. Once the data are organized into tables, they can be interpreted in the context of other data from similar studies, providing a more evidence-based form of interpretation than is possible in traditional narrative reviews.

   Under some circumstances, the numerical results of the individual studies can be pooled statistically in a meta-analysis to help interpret the results. Meta-analyses require competent statistical support, which, as in all research, should be sought before the research is planned in detail. The contributions of statisticians to research design are as important as their expertise in analyzing data.

   In most systematic reviews, the authors also grade the quality of the evidence in the review. Whether this

grading is done on the basis of the "hierarchy of evidence," quality scales, or more general assessments, trainees will have to consider the methodological quality of the articles they review. Indeed, one of the early findings of the evidence-based medicine movement was that large numbers of even randomized trials were so flawed or poorly reported that they could not be included in meta-analyses.[4]

8. *Derive conclusions on the basis of the data.* One of the reasons the discussion is the weakest part of the scientific article is that the research question was not particularly important to begin with. Systematic reviews are valuable educational exercises in part because even trainees can ask—and answer—important clinical questions. The processes of analyzing and interpreting data must be as rigorous as in any other type of research, but putting the results in context is easier when they have real meaning.
9. *Publish the results of the study.* The final stage of any form of research is publication. By the time trainees have completed their review, they may have read in great detail dozens of articles and have dealt with the problems of data abstraction. They learn through frustration the problems created by lack of clarity in writing, poor data displays, and incomplete reporting. One hopes that they will not commit the same errors in reporting that they encountered in their review. Reporting guidelines are available to help trainees prepare their manuscript for publication.[5–7]

Disadvantages Of Systematic Reviews

The essential element in conducting a systematic review is ready access to the literature. Without the ability to identify and retrieve articles of potential interest, systematic reviews cannot be conducted. Thus, the ability to search at least the standard online databases (such as Medline, EmBase, Institute for Scientific Information) is a necessity, as is access to the articles in bound journal volumes. Although online access to full-text articles is improving, the number of articles and the dates for which they are available may not yet be sufficient for conducting systematic reviews entirely online.

Depending on the scope of the review, systematic reviews can incur access and duplication costs. In one typical systematic review, the literature search identified 2,863 articles of potential interest, and 458 articles were selected for retrieval on the basis of titles or abstracts. These 458 articles had to be located on the library shelves and duplicated or acquired through interlibrary loan, even though only 42 ended up meeting the eligibility criteria for the review.[8]

A third possible disadvantage of conducting systematic reviews is that the pertinent research may be published in a foreign language. Although much medical research is published in English, much is also published in other languages. Limited English-reading ability or, for native English speakers, reading ability limited to English, can restrict the pool of articles that can be reviewed. Simply learning that many promising articles are published in a certain language, however, may be important and new information.

A last possible disadvantage is that systematic reviews are not clinical research. They involve no patient contact, no collection of clinical data, and none of the problems that can arise in clinical research (limited sample size, violated protocols, loss of blinding to group assignment, patients lost to follow-up, and so on). Neither do they involve the trainee with the issues of institutional review board approval, animal welfare, or informed consent. However, for students not planning careers in clinical research, the absence of these issues may be another advantage of systematic reviews. Those choosing clinical practice will have a much better idea of how to read and assess the literature after conducting a systematic review.

Summing Up

Systematic reviews offer distinct advantages over archival or clinical research assignments in postgraduate education, especially for trainees choosing careers in clinical practice as opposed to research. Systematic reviews should thus be acceptable in postgraduate training programs as an alternative to archival or clinical research.

References

1. Boyer EL. The Boyer Commission on Educating Undergraduates in the Research University. Reinventing Undergraduate Education: A Blueprint for America's Research Universities. Menlo Park, CA: Carnegie Foundation for the Advancement of Teaching, 1998. (Also available at ⟨http://naples.cc.sunysb.edu/Pres/boyer.nsf/⟩. Accessed 25 July 2004.)
2. Last J. A Dictionary of Epidemiology. 2nd ed. Oxford: Oxford University Press, 1988.
3. Lang T, Secic M. How to Report Statistics in Medicine: Annotated Guidelines for Authors, Editors, and Reviewers. Philadelphia: American College of Physicians, 1997.
4. for the CONSORT Group.Altman DG, Schulz KF, Moher D, Egger M, Davidoff F, Elbourne D, The revised CONSORT statement for reporting randomized trials: explanation and elaboration. Ann Intern Med. 2001;134:663–94.
5. Eddy DM. A Manual for Assessing Health Practices & Designing Practice Policies. Philadelphia: American College of Physicians, 1992.
6. Moher D, Cook DJ, Eastwood S, Olkin I, Rennie D, Stroup DF. Improving the Quality of Reports of Meta-Analyses of Randomised Controlled Trials: The QUOROM Statement. Lancet. 1999;354:1896–900.

7. for the Meta-Analysis Of Observational Studies in Epidemiology (MOOSE) Group.Stroup D, Berlin J, Morton S, Olkin I, Williamson GD, Rennie D, Meta-analysis of observational studies in epidemiology: a proposal for reporting. JAMA. 2000;283:2008–12.
8. Lang TA, Hodge M, Olson V, Romano P, Kravitz RL. Nurse-patient ratios: a systematic review on the effects of nurse staffing on patient, nurse employee, and hospital outcomes. J Nursing Admin. [in press].

BIBLIOGRAPHY OF RESOURCES FOR CONDUCTING SYSTEMATIC REVIEWS

Books

Eddy DM. A Manual for Assessing Health Practices & Designing Practice Policies. Philadelphia: American College of Physicians, 1992.
Egger M, Davey Smith G, Altman D. Systematic Reviews in Health Care: Meta-Analysis in Context. London: BMJ Books, 1995.
Hunt MM. How Science Takes Stock: The Story of Meta-analysis . New York: Russell Sage Foundation, 1997.
Cooper HM, Hedges LV (eds). The Handbook of Research Synthesis. New York: Sage Publications, 1994.
Mulrow C, Cook D. Systematic Reviews. Synthesis of Best Evidence for Health Care Decisions. Philadelphia: American College of Physicians, 1998.

Articles

Ioannidis JP, Lau J Pooling research results: benefits and limitations of meta-analysis [review]. Jt Comm J Qual Improv. 1999;25:462-9.
Irwig L, Tosteson AN, Gatsonis C, et al. Guidelines for meta-analyses evaluating diagnostic tests. Ann Intern Med. 1994;120:667–76.
Egger M, Juni P, Bartlett C, Holenstein F, Sterne J. How important are comprehensive literature searches and the assessment of trial quality in systematic reviews? Empirical study [review]. Health Technol Assess. 2003;7:1–76.
Juni P, Holenstein F, Sterne J, Bartlett C, Egger M. Direction and impact of language bias in meta-analyses of controlled trials: empirical study. Int J Epidemic. 2002;31:115–23.
Egger M, Smith GD, Sterne JA. Uses and abuses of meta-analysis [review]. Clin Med. 2001;1:478–84.
Sterne JA, Egger M, Smith GD. Systematic reviews in health care: investigating and dealing with publication and other biases in meta-analysis [review]. BMJ. 2001;323:101–5.
Juni P, Altman DG, Egger M. Systematic reviews in health care: assessing the quality of controlled clinical trials [review]. BMJ. 2001;323:42–6.
Sterne JA, Gavaghan D, Egger M. Publication and related bias in meta-analysis: power of statistical tests and prevalence in the literature. J Clin Epidemiol. 2000;53:1119–29.
Hasselblad V, Mosteller F, Littenberg B, et al. A survey of current problems in meta-analysis. Discussion from the Agency for Health Care Policy and Research inter-PORT Work Group on literature Review/Meta-Analysis. Med Care. 1995;33:202–20.
Dickersin K, Chan S, Chalmers TC, Sacks HS, Smith H Jr. Publication bias and clinical trials. Control Clin Trials. 1987;8:343–53.
Sacks HS, Berrier J, Reitman D, Ancona-Berk VA, Chalmers TC. Meta-analyses of randomized controlled trials. N Engl J Med. 1987;316:450–5.
Begg CB, Berlin JA. Publication bias and dissemination of clinical research. J Natl Cancer Inst. 1989;81:107–15.
Chalmers TC, Frank CS, Reitman D. Minimizing the three stages of publication bias. JAMA. 1990;263:1392–5.
Thornton A, Lee P. Publication bias in meta-analysis: its causes and consequences. J Clin Epidemiol. 2000;53:207–16 [a well-balanced thorough review of this topic].

Literature Search/Database Use

Savoie I, Helmer D, Green CJ, Kazanjian A. Beyond Medline: reducing bias through extended systematic review search. Int J Tech Assess Health Care. 2003;19:168–78.

Quality Assessments

Moher D, Jadad AR, Nichol G, et al. Assessing the quality of randomized controlled trials: An annotated bibliography of scales and checklists. Control Clin Trials. 1995;16:62–73.
Verhagen AP, de Vet HC, de Bie RA, et al. The Delphi List: a criteria list for quality assessment of randomized controlled trials for conducting systematic reviews developed by Delphi Consensus. J Clin Epidemiol. 1998;51:1235–41.
Juni P, Witschi A, Bloch R, Egger M. The hazards of scoring the quality of clinical trials for meta-analysis. JAMA. 1999;282:1054–60.
Verhagen AP, de Vet HCW, de Bie RA, Boers M, van den Brandt PA. The art of quality assessment of RCTs included in systematic reviews. J Clin Epidemiol. 2001;54:651–4.
Thompson SG, Pocock SJ. Can meta-analyses be trusted? Lancet. 1991;338:1127–30.

Annals of Internal Medicine Systematic Review Series

Lau J, Ioannidis JPA, Schmid CH. Quantitative synthesis in systematic reviews. Ann Intern Med. 1997;127:820–6.
Meade MO, Richardson WS. Selecting and appraising studies for a systematic review. Ann Intern Med. 1997;127:531–7.
Counsell C.. Formulating questions and locating primary studies for inclusion in systematic reviews . Ann Intern Med. 1997;127:380–7.
Cook DJ, Greengold NL, Ellrodt AG, Weingarten SR. The relation between systematic reviews and practice guidelines. Ann Intern Med. 1997;127:210–6.
Bero LA, Jadad AR. How consumers and policymakers can use systematic reviews for decision making. Ann Intern Med. 1997;127:37–42.
Badgett RG, O'Keefe M, Henderson MC. Using systematic reviews in clinical education. Ann Intern Med. 1997;126:886–91.
McQuay HJ, Moore RA. Using numerical results from systematic reviews in clinical practice. Ann Intern Med. 1997;126:712–20.
Hunt DL, McKibbon KA. Locating and appraising systematic reviews. Ann Intern Med. 1997;126:532–8.
Mulrow CD, Cook DJ, Davidoff F. Systematic reviews: critical links in the great chain of evidence. Ann Intern Med. 1997;126:389–91.
CookDJMulrowCDHaynesRBSystematic reviews: synthesis of best evidence for clinical decisionsAnn Intern Med1997126376—80

BMJ Meta-analysis Series

Egger M, Smith GD. Meta-analysis: potential and promise ⟨http://www.bmj.com/archive/7119/7119ed.htm⟩ Accessed 25 July 2004.

Egger M, Smith GD, Phillips AN. Meta-analyses: principles and procedures ⟨http://www.bmj.com/archive/7121/7121ed.htm⟩. Accessed 25 July 2004.
Smith GD, Egger M, Phillips AN. Meta-analysis: beyond the grand mean ⟨http://www.bmj.com/archive/7122/7122ed2.htm⟩ Accessed 25 July 2004.
Egger M, Smith GD. Meta-analysis: bias in location ⟨http://www.bmj.com/archive/7124/7124ed2.htm⟩. Accessed 25 July 2004.
Egger M, Schneider M, Smith GD. Meta-analysis: spurious precision ⟨http://www.bmj.com/archive/7125/7125ed2.htm⟩. Accessed 25 July 2004.
Smith GD, Egger M. Meta-analysis: unresolved issues and future developments ⟨http://www.bmj.com/archive/7126/7126ed8.htm⟩. Accessed 25 July 2004.
Egger M, Sterne JAC, Smith GD. Meta-analysis software ⟨http://bmj.bmjjournals.com/archive/7126/7126ed9.htm⟩. Accessed 25 July 2004.

Cover Note

THE COLLEGE OF MEDICINE AT THE UNIVERSITY OF ARKANSAS FOR MEDICAL SCIENCES

The College of Medicine at the University of Arkansas for Medical Sciences (UAMS) is celebrating its 125th anniversary this year. The college had a very humble beginning in 1879 as a tiny outpost of the seven-year-old Arkansas Industrial University (later to become the University of Arkansas). The main university campus was located in Fayetteville and the medical school occupied a former hotel in downtown Little Rock. Eight local physicians invested $625 each to secure a charter, and purchased the first facilities that opened October 7, 1879 with 80 students. The college would have several locations, including the original Arkansas state capitol on the banks of the Arkansas River—a stately but decrepit building it would occupy for ten years before moving into the local municipal hospital.

Today, the College of Medicine is part of the sprawling UAMS campus located in west Little Rock, which is composed of a comprehensive medical center, six colleges, and several centers of excellence and institutes, including the Myeloma Institute for Research and Therapy, the Arkansas Cancer Research Center, the Harvey and Bernice Jones Eye Institute, the Donald W. Reynolds Center on Aging, and the Jackson T. Stephens Spine and Neurosciences Institute. Last year, Little Rock philanthropist Jackson T. Stephens made a $48 million gift, one of the largest charitable donations in Arkansas history, to create the Jackson T. Stephens Spine and Neurosciences Institute.

Central Arkansas Veterans Healthcare System, one of the largest VA hospitals in the nation, and Arkansas Children's Hospital, the sixth-largest children's hospital in the nation, are affiliates of UAMS, with adjacent and nearby facilities.

The college has 25 departments and has graduated over 7,007 physicians in its history. As a medical college in a largely rural state, UAMS and the College of Medicine have fostered one of the nation's best networks of Area Health Education Centers. The college continues to make rural practice and research on rural health problems, including health insurance access, a high priority. In addition, the college has major clinical and research programs in Alzheimer's disease, osteoporosis, drug addiction research and prevention, renal disease, skull base and head and neck surgery, and programs in hearing and balance, pediatric cardiothoracic surgery, and more.

For more information about UAMS, please visit ⟨http://www.uams.edu⟩.

PAM LEIDERMANN
Director of Communications
Special Assistant to the Dean
College of Medicine
UAMS