

READING AND EVALUATING SCIENTIFIC LITERATURE



BASICS

OVERVIEW

- The ability to critically appraise the scientific literature allows clinicians to make better use of their time and efforts.
- Study designs differ in their ability to answer important research questions, and poorly designed or executed studies cannot be relied upon to provide reliable information.
- This chapter outlines the hierarchy of study designs, their advantages and disadvantages. It also includes a collection of questions that aid assessment of a study's value to specific situations.
- The chapter focuses on primary studies addressing naturally occurring disease. Laboratory (bench-top) studies, studies in healthy animals (e.g. pharmacokinetic studies) and those using disease models need to be assessed carefully in light of the available information and the situation at hand.

HIERARCHY OF EVIDENCE BY STUDY DESIGN

- Studies can be categorized as explanatory (experimental or observational) or descriptive. Examples of appropriate uses and some inherent advantages and disadvantages of common study designs are outlined below.
- The choice of study design depends on many factors including practicality. Here, study designs are listed according to a general hierarchy for the quality of evidence they can provide (adapted from Martin et al, 1987; Sackett et al, 1991; Greenhalgh, 1997b). The farther down the list a design is located, the lower the quality of evidence:

○ *EXPLANATORY STUDIES – EXPERIMENTAL*

- **Clinical trials** often evaluate efficacy of therapies or other risk-outcome relationships. **Advantages:** Prospective design under well-controlled conditions. Studies can prove causation. **Disadvantages:** Patient populations (e.g. referral populations) may not represent the population of interest.

○ *EXPLANATORY STUDIES – OBSERVATIONAL*

- **Cohort studies** are appropriate for assessing risk-outcome relationships. Cohorts are chosen to differ with regard to a risk factor and are evaluated prospectively. **Advantages:** Cohort studies can prove causation or association, and carry a lower risk of bias (due to confounding factors) than some other study designs. **Disadvantages:** Cohorts may not represent the population of interest.

- **Case-control studies** are also appropriate for assessing risk-outcome relationships. Cases are identified and compared retrospectively to matched, non-case controls. **Advantages:** Case-control studies can investigate rare diseases and can prove associations. **Disadvantages:** Relatively high risk of bias due to confounding factors. It may be difficult to prove causation unless sequences of events can be definitively established.
- Appropriate uses of **cross-sectional studies** include diagnostic test comparisons or assessment of screening tests. **Advantages:** High relevance to real-life situations and can prove associations. **Disadvantages:** Results may only apply to the selected populations. Higher risk of bias and it is difficult to prove causation.

○ DESCRIPTIVE STUDIES

- Case reports and case series can propose risk-outcome relationships and raise awareness. **Advantages:** Rapid publication (first reports); hypothesis-generating. **Disadvantages:** Cannot prove causation or associations.

HOW TO DETERMINE IF A STUDY IS WORTH READING

- The abstract should communicate why study was performed, how it was performed, and what the outcomes mean.
- Critical evaluation of scientific studies can be viewed as having two goals. The first is to establish whether the study was designed and executed well enough to allow the reader to accept the results (internal validity), and the second is to determine whether the study results are applicable to a specific situation (external validity). The second question may be easier to answer than the first based on a quick review of the abstract, and the reader may forego reading a study in detail when the results – however valid they may be – do not apply to the patient population or the clients' production systems that you are attempting to retrieve information for.
- Once it is decided to read the entire article, the reader should concentrate on a critical review of the methods and results sections to find out whether the authors designed and executed the study in a valid way, and whether the reported outcomes are relevant to the situation that the reader is relating the study to.

QUESTIONS TO ASK WHEN ASSESSING A STUDY'S VALUE

In-depth questions, adapted from Greenhalgh (1997a, 1997b) that should be considered when determining a specific study's value to the reader/clinician:

1. **Why was the study done, and what questions does it address?**
 - a) Are these questions important to you?
 - b) Was the study original?
 - From the introduction section, the scientific questions being asked, and their context, should be clear. A hypothesis or objectives should be stated. You should be able to decide whether the study has relevance to you.
 - If a study is not original, decide whether it was worth performing. Perhaps it was performed under different conditions, with different types of animals, or with a larger group.
 - There is sometimes value in showing that the results of a previous study can (or cannot) be replicated.
2. **What type of study was this?**

- a) Is the study design appropriate for the question(s) being asked?
 - A “primary” study implies that the work was entirely done by the authors. The hierarchy of evidence list will guide the reader in determining whether the study’s questions are appropriately addressed by the chosen study design.
 - A “secondary” study (i.e., a systematic review, meta-analysis or an economic expansion of others’ work) pulls together results from multiple studies and examines them as a group. The quality of secondary studies is largely a function of the quality of individual studies and selection criteria should be reviewed carefully. Well-conducted secondary studies are very powerful.
- 3. Was the study designed and executed properly?**
- a) What type of animal or production system is addressed?
 - b) What were inclusion and exclusion criteria for study animals or “cases”?
 - c) Were appropriate controls chosen?
 - d) What “interventions” (including risk factors) were studied and are these relevant?
 - e) What outcomes were measured and are these relevant?
 - f) Was systematic bias avoided or minimized?
 - g) Were all subjective assessments “blind” (important for clinical trials, cohort and case-control studies)?
 - h) Were preliminary statistical issues dealt with?
 - i) Was the study large enough, and continued for long enough, to make the results credible?
 - j) What assumptions were made and did they make sense?
- The populations(s) studied and the measured outcomes should be relevant to the reader’s practice situation. As an example, a clinical trial in a referral population may not be applicable to populations encountered in general practice.
 - There are many ways to inadvertently introduce bias, starting with the selection criteria and group assignments. One simple question to ask is “Were there any systematic differences between groups other than the studied intervention?”
 - Questions g) and h) are especially pertinent for clinical trials. The authors should address sample sizes, the magnitude of difference between groups they aimed to detect, handling of losses from the study, and the way data were recorded and validated. Determine whether the duration of the trial (or follow-up) was long enough to identify both positive and negative outcomes.
 - For studies on modeling or economics, question i) is especially important as the assumptions may not apply to the situation you are investigating. Look for any hidden assumptions, e.g., did the authors assume a certain housing or marketing system?
- 4. Is the study sufficiently complete for its frame of reference?**
- a) Does the study address areas of major importance, or at least acknowledge important areas that were omitted?
 - b) For economics studies, are costs and benefits addressed from a viewpoint, or frame of reference, that is relevant to you?
 - c) Does the study conclude with a recommendation for action or change in behavior or practices?
- Recognizing that no analysis is ever truly complete, ask whether the study accounts for items that are important to the particular area, industry and time it considers. Are these the same items that are you and your client(s) are most concerned with?

- Ideally, studies report both economic and biological outcomes—the dollar values of outcomes may change over time, but biological outcomes are less likely to change.
- Economics research can be written from the frame of reference of society/the government or of the producer/practitioner. In the former case, benefits accruing to the public are considered true benefits, whereas costs assumed by producers may not be considered program costs (Hanson and Hanson, 1983).
- Valuable articles should end with recommendations derived from the work, or at least outline proposed solutions for answering remaining questions.



MISCELLANEOUS

Suggested Reading

Dohoo, IR and Walter-Toews, D. 1985a. Interpreting clinical research Part I. General considerations. *Comp Cont Educ Pract Vet* 1985; 7(8): S473-S477.

Dohoo, IR and Walter-Toews, D. 1985b. Interpreting clinical research Part II. Descriptive and experimental studies. *Comp Cont Educ Pract Vet* 1985; 7(9): S513-S518.

Dohoo, IR and Walter-Toews, D. 1985c. Interpreting clinical research Part III. Observational studies and interpretation of results. *Comp Cont Educ Pract Vet* 1985; 7(10): S605-S612.

Greenhalgh, T. 1997a. How to read a paper: Getting your bearings (deciding what the paper is about). *Bri Med J* 315:243–246.

Greenhalgh, T. 1997b. How to read a paper: Assessing the methodological quality of published papers. *Bri Med J* 315:305–308.

Greenhalgh, T. 1997c. How to read a paper: Statistics for the non–statistician. II: “Significant” relations and their pitfalls. *Bri Med J* 315:422–425.

Martin, S.W., Meek, A.H., Willeberg, P. 1987. Veterinary Epidemiology. Iowa State University Press, Ames, IA.

Sackett, D.L., Haynes, R.B., Guyatt, G.H., Tugwell, p. 1991. Clinical Epidemiology: Science for Clinical Medicine. Little, Brown, and Co., Boston.

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