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When Plagiarism Becomes Research

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There are three possible levels of analysis in clinical research. Primary analysis deals with the original analysis of research study data. Secondary analysis is a reanalysis of the original data, either to address the original question through better techniques or to address a new question using old data. Meta-analysis is a statistical analysis of many studies done to summarize a body of literature. Meta-analysis is particularly helpful in an area in which original research studies have produced conflicting results because it enables analysis of the impact of study characteristics upon the end result.

The family practitioner as a consumer of research needs to become familiar with the technique of meta-analysis because it is appearing with increasing frequency in the medical literature. Still somewhat controversial, meta-analysis requires a rigorous approach to ensure its validity: this editorial is written to assist the family practitioner in an understanding of the meta-analytic technique and point out important features that need to appear in any published meta-analysis.

FEATURES OF META-ANALYSIS

Meta-analysis involves the pooling of results across studies. This differs from data pooling in which individual subjects are pooled. To use data pooling appropriately the studies from which the subjects are gathered must be sufficiently similar to warrant such pooling. Meta-analysis, on the other hand, does not rely on similarities in the study setting or design. The unit of analysis for meta-analysis is the individual study and the differences in study design are utilized to investigate the impact of study characteristics upon study outcome.

Meta-analyses have several essential features. The location of studies to be included is essential because meta-analysis seeks to review the entire body of literature. Inclusion and exclusion criteria for studies must be clearly specified in a meta-analysis. Study characteristics are described in detail for each study and the study outcomes are quantified through the use of an effect size. The effect size can take several different forms, but is used to measure the overall difference between experimental and control groups in a standardized fashion.

The identification of studies to be included is a critical step in a meta-analysis. Published studies should be identified through reviews of bibliographies, books, and computer searches. However, meta-analysis needs to include as many unpublished studies as possible. Publication bias—the fact that unpublished studies have a smaller effect size than published studies—is evident in several areas of research. Consequently, if publication bias is to be eliminated as a problem, unpublished studies must be located. Clinical reports, dissertations, and conference reports are all sources for the identification of unpublished studies.

Once potential studies are identified, criteria for inclusion and exclusion must be applied. Although some meta-analysts believe that all studies should be included in any meta-analysis, a practical approach is to require every included study to clearly address the study question and include an adequate documentation of exposure as well as an appropriate control group. Limiting your meta-analysis to only high quality studies may drastically reduce the number of studies included and restrict its ability to identify the impact which study parameters have upon outcome.

Because an essential part of meta-analysis is to identify the role of study design characteristics upon outcome, a detailed description of study characteristics should be encoded in any meta-analysis. Such features as study site, sampling techniques, sample demographics, statistical power, and publication characteristics should all be included.

The final key step is the quantification of study outcome, as previously mentioned. Classically, the effect size index is measured as the standardized difference between the means of the experimental and control groups. The standardized difference can be obtained by dividing the difference by the pooled deviation for the entire sample. Other measures of effect size can include the natural logarithm of the relative risk, t statistics or correlation coefficients. When more than one effect size can be derived in any study, the selection of a key or 'best' effect size is important. In those situations where any selection of a key effect size would be arbitrary, the use of a Jack-knife technique

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to select an overall representation for the study is possible.

ANALYSIS IN META-ANALYSIS

Perhaps the first step in the analysis phase of meta-analysis is the description of the studies themselves and their quality. Presentation of frequencies and means for the individual study characteristics is very valuable in the description of the overall quality of the literature upon which the meta-analysis is based. Because some variables involve a subjective judgment on the part of the meta-analyst, presentation of interrater agreement on these variables is important.

Summarization of the overall findings of the literature can be done in one of three ways. The use of voting methods in which the number of 'significant' studies is tabulated is notoriously unreliable and a poor way of summarizing the literature. The effect size can be summarized by calculating the mean key effect size across the studies with the presentation of confidence intervals. This is best done using a weighted effect size which adjusts for differences in sample size from one study to another. The final method of combining outcomes is by combining *P* values of the individual effect sizes in the studies. Although this can be done by one of several methods, combining *P* values only gives you a sense of the overall level of significance of the literature rather than the overall effect size of the literature.

A final step in summarization should include an assessment of publication bias. This can be done graphically through the use of a funnel graph or can be done through the calculation of a fail-safe *n*—the number of unpublished studies having no effect that are needed to bring the mean effect size to a level of non-significance. Every meta-analysis should include some assessment of publication bias.

A final analysis phase in any meta-analysis should be an assessment of the relationship between study characteristics and outcome. This should include not only univariate analyses, but also an overall multivariate analysis, using techniques such as multiple linear regression, logistic regression, etc. Only through these analyses can an understanding of the source of conflict in a body of literature be truly determined.

INTERPRETATION OF META-ANALYSIS

The statistical interpretation of any meta-analysis is relatively straight forward if the analyses described above are used. For the practitioner, an empirical interpretation may be more valuable.

Usually one of three situations exist in any meta-analysis. The interpretation differs, depending on which of the three situations apply. If most studies in a meta-analysis point in the same direction you should probably accept that conclusion. In this case, the large high quality studies will give the reader a rough estimate of the effects of mass implementation of whatever treatment is being investigated.

A second possible outcome is that the effects differ between high quality studies and poor studies. In this situation, our interpretation should lean in favour of results of the high quality studies.

Finally, it is possible that the high quality studies have found inconsistent or conflicting results. In this case, you must look at the analysis of the relationship between study characteristics and outcome. If our multivariate analysis suggests that the better the study design, the higher is the effect size then that suggests that there is indeed a relationship. On the other hand, if the effect size is larger in situations where study features are more poorly controlled, then that suggests that there may not be a significant relationship and that any observed relationship may be due to artifact.

CONCLUSION

The technique of meta-analysis is extremely valuable in summarizing a large body of research as well as in explaining conflicting results. Many issues of great concern to family practitioners could be very appropriately addressed through the use of meta-analysis, such as the efficacy of various weight-loss techniques, smoking reduction techniques, and therapies in substance abuse. The medical literature, in general, and the family practice literature, in particular, are beginning to include meta-analysis in their publications. It is extremely important for the family practitioner to understand what meta-analysis is, and be able to read and interpret a meta-analysis.