Information Synthesis: A Practical Guide

Peter G. Goldschmidt

Information synthesis is one of the most valuable contributions a scientist can make. This paper offers guidance in preparing information syntheses and a means of assessing their adequacy. Preparing an information synthesis requires four steps: (1) defining the topic and relevant information about that topic, the purpose of the synthesis, and the target audience; (2) systematically gathering this relevant information; (3) assessing the validity of such information; and (4) presenting validated information in a way useful to the target audience. This paper presents guidelines and criteria for each step, and some helpful hints for authors in preparing an information synthesis.

Decisions must be made in practice whether or not solid information exists. Information for decision making may be drawn from research or, more usually, from the experience or assumptions of the decision maker. Information synthesis is one of the most valuable contributions a scientist can make. By systematically gathering, evaluating, and presenting information in a form useful to the intended audience, information synthesis creates order out of chaos. As a focus for the accumulation, integration, and interpretation of knowledge, it forms a basis for additional research. Despite this potential contribution, current information synthesis is usually informal — and formal syntheses are needed. The proliferation of publications makes formal information syntheses not only necessary but difficult to accomplish. Today's scientific establishment emphasizes empirical or observational research, seemingly no matter how trite or trivial in nature. Coupled with the "publish-or-perish" imperative, this emphasis has resulted in informa-

tion pollution. In a very real sense, today's problem reflects not only the lack of information, but also its overabundance and a concomitant lack of integration or organization. Put simply, so much information is being generated and disseminated that the information we need is being obfuscated in the process. Mechanisms instituted to cope with the "information explosion" — such as automatic citation bases — tend to worsen the problem, while giving false reassurance that the situation is improving; information in fact remains inaccessible and unevaluated.

The prevailing approach to information management may be conveniently labeled "trash compacting" — ever more "information" is indiscriminately compacted into a smaller and smaller space (now through microprocessors). Reports are replaced by abstracts; abstracts by titles; paper by microfilm; microfilm by electrons. In the ultimate analysis, however, these electrons still represent only the original information: if garbage goes in, only garbage can come out — if it can be retrieved at all. It is of little consolation that it can all be done at the speed of light. "Panning for gold" offers an alternative approach, in which relevant information — a nugget of gold — is extracted from the material in which it is embedded. Furthermore, since all that glitters is not gold, this approach recognizes explicitly that the validity of relevant information must be assessed to extract those truly golden nuggets for which we search — relevant, valid information. In summary, present approaches tend to assume that all information is equally valid and important; the suggested approach recognizes explicitly that this is not so.

Despite their obvious value, few incentives exist to create good information syntheses. The task, which is mostly taken for granted or delegated to "spare time," requires both considerable subject matter and information management knowledge, as well the consumption of valuable time and resources. Furthermore, if done well, it is likely the task of a multidisciplinary expert group (rather than the domain of the lone individual). Interest in information synthesis has increased recently, manifest, for example, by a major study [1] and report [2]. Moreover, in the Veterans Administration, information synthesis has the highest priority of any type of health services research and development [3].

The dearth of formal information syntheses is paralleled by a paucity of articles on how to prepare them. This paper is intended to remedy this deficiency. It (1) defines an information synthesis (and compares and contrasts it to a critical review of the literature and other forms of information summarization); (2) provides guidelines for syn-

thesizing information; and (3) gives some hints to authors for preparing information syntheses.

The guidelines presented here stem from the author's perspective as a user of information (rather than as an archivist or scientist concerned primarily with generating information), as well as the experience he gained in examining the relevance, accessibility, and validity of applied health science information. This guide does *not* provide details on how to conduct all of the steps necessary to develop an information synthesis; where appropriate, some references are provided to locate such guidance. This paper should be of interest not only to researchers who generate and summarize scientific information, but also to the potential users of such information. A special section discusses use of the guidelines for preparing an information synthesis as criteria for evaluating the adequacy of an information synthesis.
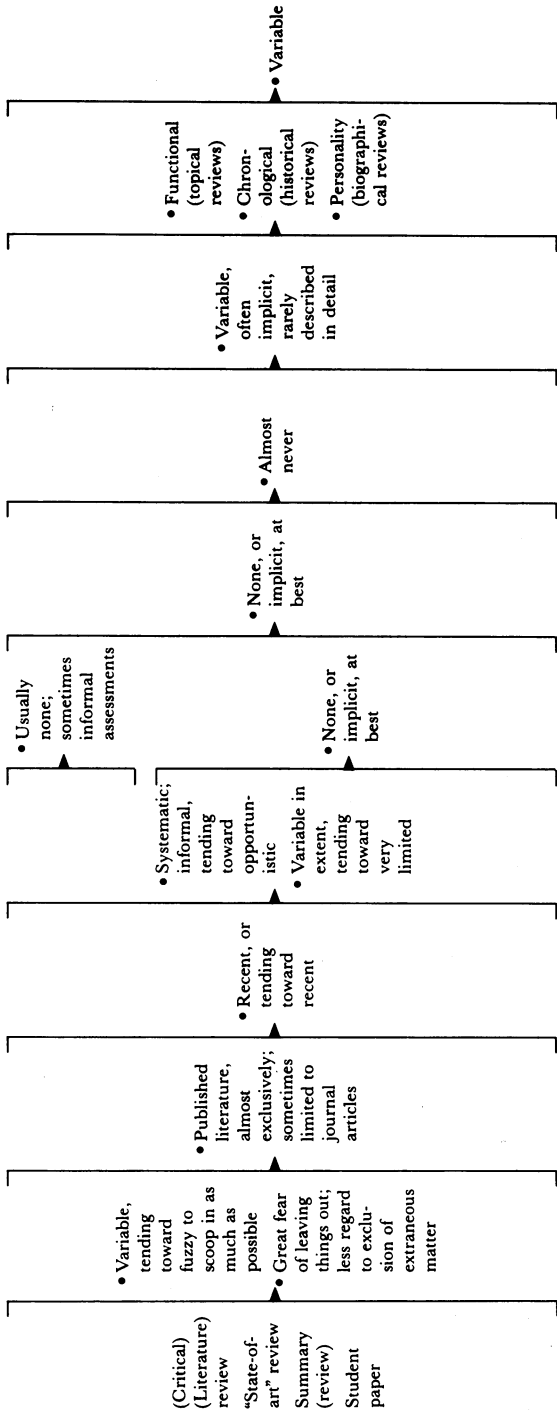
INFORMATION SYNTHESIS DEFINED

Scientific research results in written reports, usually published in journals. The findings in these reports form the basis of an information synthesis. They are analogous to the observations upon which empirical research reports are based. An *information synthesis* results from the systematic gathering of research findings on a defined topic for use by a specific audience for a given purpose; the systematic assessment of their validity; and the presentation of valid findings in a form useful to the intended audience, including a discussion of critical information gaps that should be the subject of subsequent research. Thus, an information synthesis involves four steps: (1) topic definition (to determine the information that is relevant); (2) systematic information search (to find relevant information); (3) validity assessment (to identify valid information from among that which is relevant); and (4) presentation of relevant, valid information in a manner useful to the intended audience. *Valid information* refers to research findings that are substantiated by the reported methods used to produce them. This concept is expanded upon here in a later section.

An information synthesis differs in important ways from other approaches to information summarization, often referred to as secondary scientific reports—secondary in the sense that they summarize empirical, primary research reports (see Figure 1). Most important, as the term suggests, an information synthesis is limited to the synthesis of *existing* information (whether published or not).

Information synthesis is not just another term for literature

Figure 1: Comparison of Some Approaches to Information Summarization Based upon Topic Definition, Information Sources, Evaluation, and Presentation

Approach	Topic Definition	Information Sources			Information Evaluation			Information Presentation		
		Types	Period	Collection	Existing Data	Certainty of Validity	Synthetic Data	Methods	Results	Discussion
State-of-science report	• Precise • Major subject • Structured criteria of relevance	• Published, unpublished literature • Expert extrapolations, assumptions	• All (except if update, then recent)	• Systematic, formal • Extensive	• Systematic, formal • Multiple judgments	• Explicit, • Systematic, formal	• Always • Existing data methods • Structured judgments	• Described in great detail	• Organized for use, reference	• Rarely
Information synthesis	• Precise • Defined, tending to narrow • Definite criteria of relevance	• Usually published; sometimes unpublished literature • Occasionally expert opinion	• Defined, may be all or recent	• Systematic, formal • Resource constrained tending toward extensive	• Systematic, formal • Usually involves multiple judgments	• Usually implicit; sometimes may be considered explicitly	• Sometimes • Limited to existing data methods	• Described in detail	• Organized to suit purpose, intended audience	• Always

(Critical) (Literature) review	• Variable, tending toward fuzzy to scoop in as much as possible	• Published literature, almost exclusively; sometimes limited to journal articles	• Recent, or tending toward recent	• Systematic; informal, tending toward opportunistic	• Usually none; sometimes informal assessments	• None, or implicit, at best	• Almost never	• Variable, often implicit, rarely described in detail	• Functional (topical reviews)
"State-of-art" review	• Great fear of leaving things out; less regard to exclusion of extraneous matter			• Variable in extent, tending toward very limited	• None, or implicit, at best				• Chronological (historical reviews)
Summary (review)									• Personality (biographical reviews)
Student paper									• Variable

review. Literature reviews, of the type published today, are usually less systematic both in gathering information and in assessing its validity than the guidelines proposed for an information synthesis. In other words, an information synthesis differs from a literature review in its sharp focus on a specific problem or question; its systematic search for relevant information; its explicit and structured assessment of the validity of information contained in research reports; and its presentation of relevant, valid information in a manner designed to facilitate its use in practice. Where gaps in information exist (identified by comparing what should be known to what is known with acceptable certainty of validity), they are described, becoming the potential targets for further research in the topic area. State-of-the-science reports, in contrast, use expert opinion or other appropriate techniques to provide needed but missing information for use in decision making until more solid empirical estimates result from additional research.

An information synthesis may include a *meta-analysis*, the statistical manipulation of findings from multiple research studies. I prefer this narrow definition of meta-analysis, excluding, for example, the pooling and reanalysis of data from multiple studies. Should meta-analyses use only findings that result from valid studies or use those from any study no matter how inadequate the methods used to generate them? My suggestion is that meta-analyses use findings only from studies that meet the minimum criteria of scientific adequacy until empirical determination indicates that both approaches lead to the same conclusions.

GUIDELINES FOR SYNTHESIZING INFORMATION

This part of the paper presents some guidelines for each of the four steps involved in synthesizing information. Each of the following sections provides general guidance and points to specific criteria, listed in the appendix.

DEFINING THE TOPIC, INFORMATION NEEDS

One can hardly overemphasize the need to define precisely what information is relevant to the purpose in mind or the task at hand; this obvious step is often overlooked or done poorly. During the early stages of an information synthesis, topic definition may be dynamic: an initial definition may be revised as the result of information gathered during

the process. However, at some time lines must be drawn to define precisely what is (and is not) relevant before the synthesis can be completed successfully. The synthesizer has three tasks: (1) to decide the information that needs to be synthesized (topic), why (purpose), and for whom (target audience); (2) to define the topic; and (3) to establish the exact relevant information.

Information synthesis is a time- and resource-consuming activity; thus, the rule: make the task manageable. Define the topic as narrowly (rather than as broadly) as possible to suit the purpose and the target audience. A good way to begin is to define the general concept, refining the topic by describing specific inclusions and exclusions; they may be grouped in sub-topics. Make no mistake: topic definition is no easy task, and may involve considerable time and effort. For example, in the Medical Practice Information Demonstration Project, teams of experts were used to develop definitions for such health problems as bipolar disorder [4].

Once the topic is defined, you need to decide exactly what information is relevant. For example, if your topic is bipolar disorder, what exactly do you want to know: prevalence (among whom?); treatment efficacy (outcomes? among whom? by what practitioners? using what procedures?) The list of questions can seem to be endless, but precise specification will aid the search for information by providing clear-cut *criteria of relevance*. Your way of defining the topic has important implications for the particular information you will find. Use generally accepted concepts in preference to those you favor; deviate only when necessary. Make a note of different terms used to represent the same concept or similar ones; decide how you will group them; record these decision rules. The standard use of concepts will facilitate making comparisons of definitions comprised of these concepts. If your definition is at variance from those in the literature, you will have to extrapolate from documented facts, or at least examine the significance of the incongruousness. Lack of a standard definition in the field will present problems in information synthesis. Where no standard definition exists, the author may make a valuable contribution by providing one. Furthermore, a definition itself may be the appropriate topic for an information synthesis.

GATHERING INFORMATION

Often available information is not readily accessible. Thus, one must adopt a systematic approach to identifying relevant information; you cannot rely on the present contents of your reference files, nor can you

expect to identify much relevant information using automated citation bases, and, in some instances hardly any information, relevant or not (because of limitations in sources and indexing, for example). Furthermore, your search for information must be time- and resource-constrained — because you know how much time and money you have to devote to this purpose, but you will never know when you have identified all relevant information. You will also need to develop strategies to get the maximum use from the resources you do have available.

As soon as you have defined exactly what information you are seeking (by establishing criteria of relevance), you can set about the task of gathering it from one of two sources, or both simultaneously. They are: (1) the literature, including machine-readable citation bases and other documents; and (2) experts, however defined. The problem with accessing the literature through machine-readable citation base indexes is the serious limitations of available descriptors and the large number of irrelevant citations that must be screened to identify relevant articles. For example, articles on the quality of the medical science literature cannot be accessed directly through Medlars; yet seemingly relevant descriptors would yield citations to irrelevant papers [5]. Moreover, if specific data are sought, they may not be found, or if found, may not conform exactly to the requirements. Experts may be solicited to identify relevant citations or articles. The difficulties inherent in this approach include defining criteria of expertise and identifying the individuals who meet them. Once identified, however, experts can often rapidly provide leads to potentially relevant literature, without needing to screen many irrelevant citations, and can give you some idea of its extent. Contact with many experts is preferable to contact with a few, because an individual expert may be familiar with only a fraction of the relevant literature.

Different strategies are appropriate for gathering information from documents or experts, or a combination of both. In fact, effective information management requires determining prospectively whether one type of source should be used in preference to the other, or their appropriate phasing if both are to be used. Structured techniques are available to gather information from documents and from experts, and through using a combination of both sources. Their purpose, and that of information management in general, is the cost-effective use of resources to elicit needed information. Generally, such techniques monitor the productivity of various search strategies to guide the further direction of the particular search. The remainder of this and later sections is limited to gathering information from the literature and other documents (however identified), in line with the definition of an

information synthesis provided above. The reader should keep in mind constantly, however, that actually eliciting information from experts (rather than the literature) may be a practical alternative, or, in some instances, the only method for providing validated information for use in practice.

When searching the literature, never underestimate the task, and remember that a good job involves effort beyond the obvious. To conduct a cost-efficient search you must (1) establish criteria of relevance; (2) delineate your resource and time constraints; and (3) use a structured method to keep track of the search and its productivity. If you do not want to develop your own method, complete systems are available — for example, that used by Policy Research Incorporated [6]. This latter system uses an A-B-C approach to classify articles: "A" = relevant; "B" = may be relevant (too little information to judge definitely); and "C" = not relevant. Initially, you will usually have to judge an article's relevance from its title (hence the importance of an appropriate title) or from the title plus key words. All "A" (i.e., citation-relevant) articles should be retrieved, read, and judged, finally, for relevance (i.e., article relevance). Samples of "B" and "C" citations should also be retrieved early in the search to estimate false negative rates (relevant articles classified as possibly or not relevant) and to refine the established criteria of relevance. False negative rates (titles classified as relevant when the articles in fact are not) can be determined from the "A" citations retrieved and the results used to refine further the established criteria of relevance.

The relevant information in an article must be identified, to assess its validity, and sorted for subsequent content analysis. Put simply, the problem is that articles may contain one or more information elements, which must be organized by element. Several structured methods are available to facilitate this sorting. Perhaps the most widely used is that of abstracting the relevant information onto record cards (one card per article/element). Cards are prepared one article at a time, and then sorted by element for analysis. This procedure is excellent when a small number of articles and elements are involved, but it becomes more and more tedious as their number grows. The same unit record principal, however, can be implemented through computerized systems. Here information is coded (a hierarchical structuring of criteria of relevance helps) and converted to electronic form for organization by computer. Information can be retrieved by element or combinations of elements, as well as by article. Very large amounts of information can be handled this way, although setting up such a system can initially be quite costly

(the cost of hardware is decreasing, but appropriate software may still be expensive).

ASSESSING INFORMATION VALIDITY

Effective information management requires resisting two common tendencies: (1) believing that information in published documents is valid for your purpose; and (2) assuming that all information is equally valid. Available evidence indicates that medical information is more likely to be unsubstantiated than not, and the more positive the claim, the lower the probability that the claim is valid [7]. Thus, the validity of assembled information must be assessed systematically.

What is validity? Clearly, this concept could itself be the topic of a useful information synthesis. However, as used here, validity means that research findings are substantiated by the reported methods used to produce them at some preset level of methodological adequacy. Thus, validity is both relative and judgmental. The validity of information generated by experiments or other empirical observation can be assessed by (1) examining the methods used to produce it and (2) establishing the limits of generalizability. Again, structured procedures are available for this task [8]. In the case of relevant information resulting from a clinical trial, for example: was it designed, implemented, and analyzed (including statistical procedures) in such a way that the resultant data are likely valid? In other words, to what extent can the resultant data be substantiated based on an examination of the reported methods used to produce them? This examination of research process to assess research results relies not only on what is reported about methods but also on expert judgment, both to identify criteria and standards and to assess the extent to which a given study meets them. Who should make these judgments? Generally, biostatisticians and other methods experts are required to establish criteria for judging research adequacy. Such experts are also required to assess the adequacy of individual research studies; clinical or substantive experts may not be qualified to judge scientific validity. Further, because a single individual may misread, misinterpret, or misconstruct information in a research report — or miss critical information entirely — a team of assessors is preferable to a single assessor. In case of disagreements, assessors can discuss their contentions and develop a consensus judgment. The validity assessment procedures referenced previously suggest that a team of three methods experts be used to assess the validity of research findings. The Veterans Administration Health Services Research and Development Service uses a panel of three experts — a

researcher-clinician, substantive expert, and methodologist—to assess the adequacy of project reports; experts are selected for their knowledge of the project topic.

Even systematic assessment methods have their limitations, of course; well-designed experiments can produce false data; and, conceivably, the results of poor experiments may be true. Furthermore, in making judgments about the validity of information, one can rely only on the documentation provided. A good experiment may be poorly reported, leading one to conclude that the resultant information is not substantiated by the methods. (This is appropriate because science depends inherently upon documented findings substantiated by scientific methods, not upon their acceptance on faith.) On the other hand, one has no guarantee that an experiment which appears well designed and so on, according to its description, was, in fact, conducted as reported—or conducted at all. Recent reports of fraud in medical science attest to this latter problem (for example, see [9]). Nevertheless, despite these uncertainties, formal assessment of information validity is a necessary part of a useful information synthesis.

PRESENTING RESULTS

Your presentation of information may be as important as the information itself. Valid information poorly organized and presented may not be used. Since, in the final analysis, information is only useful if used, or at least considered, in decision making, the final step is at least as crucial as those that precede it. The information to be presented consists of two types: (1) the information synthesis process and its results; and (2) the informational outcome of that process.

From the process, you will know such things as: the sources you searched for relevant citations; the number of articles you reviewed; how many of them contained any relevant information; and of those latter articles, the number that contained valid information. These facts and figures should be presented to inform the reader of the extent to which your search was exhaustive, comprehensive, and thorough, and of the state of the literature on the subject.

The outcome of the process is identification of the relevant, valid information you set out to find. This information should be presented in a manner useful to the reader. The best form of presentation, of course, will depend on the subject and the target audience. Often the criteria of relevance (established for the information search) indicate the proper presentation. Remember that it is as important to state information that does not exist as to identify the valid, available infor-

mation. Furthermore, if unsubstantiated or dubious information has been found, it (and its sources) should be identified explicitly to warn the reader. Good writing skills are needed to present information well. Articles and books designed to sharpen these skills are readily available (for example, see [10]). You may want to use one or more meta-analytic (statistical) techniques to synthesize data, as well as reporting relevant, valid information contained in research reports. How to incorporate these techniques into information syntheses, however, is beyond the scope of the present article.

USE OF CRITERIA FOR EVALUATING THE ADEQUACY
OF AN INFORMATION SYNTHESIS

The criteria in the appendix may also be used to assess the adequacy of an information synthesis. Thus, they may be of value to a user of information, as well as to scientists interested in its synthesis. When used to assess the adequacy of an information synthesis, the reader should answer the questions (criteria) in one of the following six ways: (1) not applicable; (2) need help to evaluate; (3) yes; (4) not determinable; (5) no, minor flaw; (6) no, major flaw. In forming judgments, the reader should evaluate only the contents presented, and not give the author of the information synthesis the benefit of a doubt. Thus, if one cannot determine whether or not a criterion is met, one should assume that it is not and judge it accordingly — as a minor or major flaw. The checklist questions are not intended to represent a series of test results which are summed (in either a weighted or unweighted manner) to yield an adequacy score. Rather, they are intended to identify for the reader the potential flaws that exist in the information synthesis, and the extent to which such flaws detract from its adequacy. Ultimately, the reader (user of information) must reach a summary judgment about the adequacy of the information synthesis for the use to which he/she intends to put it. The checklist questions (criteria) are designed to facilitate this step. Finally, when developing an information synthesis, its author should be mindful of the criteria and the approach to evaluating the adequacy of the information synthesis suggested here.

SOME HINTS TO AUTHORS IN
PREPARING AN INFORMATION SYNTHESIS

This section provides some practical advice to authors in preparing an information synthesis. The synthesis should follow the classic outline of

any scientific research paper: introduction, methods, results, and discussion. The appropriate content and layout of each section, especially the results section, will depend on the purpose of the information synthesis, the target audience, and the specific topic. However, you may find the following hints helpful. They encompass: title, abstract, introduction, methods, results, discussion, references, and manuscript preparation.

THE TITLE

A reader may decide whether or not to read a paper based solely on the title or (if one is lucky) the title and abstract. Since the title alone usually survives in the automated citation base and other reference retrieval mechanisms, it should be short and to the point. Cryptic titles may be fun, but they are usually not informative and are best avoided. The words "information synthesis" should appear in the title — for example, "The Treatment of Malignant Melanoma: An Information Synthesis from the Literature." The term "state-of-the-science report" should be reserved for compellingly comprehensive works in which valid research findings are supplemented and complemented by extrapolations or expert opinion.

In addition to the title, the manuscript title page should list: the name of each author (with academic degrees); each author's professional/faculty title(s) and institution(s); the name and address of the author to whom correspondence or requests for reprints should be addressed; sources of support, if any; acknowledgments; and any disclaimers or other pertinent information.

THE ABSTRACT

The abstract may be written first or last — or both. Writing the abstract first permits the author to decide prospectively the critical elements of the paper. Writing it last permits him/her to sharpen the abstract to reflect the truly essential information in the paper (or to identify retrospectively the critical elements of the paper). Since the abstract serves to summarize concisely the paper's content, it must be concise (200 words maximum, or less for some journals); yet it should be able to (and may well have to) stand alone and be self-contained. It should contain no information that is not also presented in the paper.

The contents of an information synthesis abstract parallel those of an experimental study. The opening sentence should provide the context for the paper. The remainder should state the paper's purpose

(referring explicitly to the topic and information about that topic encompassed by the synthesis); the basic procedures used to identify and assess information; relevant valid findings, emphasizing outcomes in preference (but in relation) to process; and principal conclusions — what is known about the topic, how well it is known, and the critical information gaps that should be filled by new research. New insights gained by completing the information synthesis should be emphasized.

THE INTRODUCTION

Provide a brief background to or context for the information synthesis. State precisely its purpose. Why did you undertake it? Define the topic covered. What exactly is included? Excluded? Describe what information on the topic is relevant. Why is it relevant? To whom? For what purpose? If appropriate, identify previous reviews of the literature on the topic and their defects. How does your information synthesis differ from previous efforts or reviews? This information will set the context for and identify your contribution.

THE METHODS SECTION

Describe clearly and precisely how you identified and assessed relevant information. Remember, each relevant document you identified represents a data source; it is equivalent, for example, to a completed interview in an empirical research survey; you must provide analogous information (to sampling design, completion rates, data analysis, etc.). Identify methods, procedures, and so on in sufficient detail to permit other authors to check, replicate, or extend your work. For an information synthesis, this means describing, for example, the literature search strategy, the citation bases searched, and how they were searched. The methods section should describe what actually was done. If what was done differs materially from what was planned, describe the differences and the reasons for their occurrence.

Reference may be made to published procedures (or established statistical methods), but describe new or substantially modified methods, or methods that may not be well known — especially if they are essential to judging the adequacy of the information synthesis. Where appropriate, give the rationale for selecting a method (in preference to another), and its limitations. If you pooled observations, conducted meta-analyses, or extrapolated from published findings, you must describe exactly what you did and why, state your assumptions, and

evaluate pertinent limitations. If complex manipulations are involved, put the technical details in one or more appendixes.

THE RESULTS SECTION

Two types of results are of interest: findings pertaining to the literature or documents reviewed; and the relevant, valid data that they contain. With respect to the former, summarize: the number of citations reviewed and the number marked relevant, the number of relevant citations that could be retrieved, the number found relevant after review of their contents, and the number of studies providing valid data. Provide a detailed summary of the flaws found in each study reviewed that detract from its validity or render it invalid; be sure to link the flaw to the study.

Array relevant valid data (identified in source documents) in a logical manner useful to the intended reader. This information should precede any reanalysis, meta-analysis, or intra- or extrapolation involving such data. Use tables, charts, etc. to summarize information. Do not repeat in the text what is in tables, charts, etc. However, in the text, draw the reader's attention to particularly important data contained in a table, chart, etc:, and emphasize critical findings. Leave interpretation of results for the discussion section.

THE DISCUSSION

Summarize what is known about the synthesis topic and how well it is known, but avoid repeating in detail data presented previously. What are the implications of the state of knowledge? What do you recommend now? Identify critical information gaps that should be filled by new research, and indicate whether such research involves repeating badly done studies or designing entirely new ones. Comment on the feasibility of providing valid information and on the practicality of conducting needed research.

THE REFERENCES

The references are the equivalent of the observations documented in an experimental research report. Thus, facts cited in the information synthesis must be referenced precisely; vagueness must be avoided.

Reference can be made only to *documented* facts. The following are unacceptable: verbal personal communications; notes made at conferences. The following are acceptable, but should be avoided, if at all

possible: written personal communication (letter); meeting transcripts; and unpublished papers (in press or otherwise). (As used here,"unpublished" is not synonymous with "not published in a journal"; corporate and government reports are published documents.) In the case of documents that may not be readily accessible, the reference must include sufficient information to enable the reader to obtain a copy. In general, journals suggest that only published (or in press) documents appear among the references, and that information from documents not intended for publication or not yet accepted in a journal be cited in the text.

Use preferably the citation-by-number system for references, because this is the system now accepted by over 200 medical journals. Number references consecutively in the order of their first mention in the text. Identify references in text, tables, and legends by Arabic numerals (in brackets or parentheses). References cited only in tables or in legends to figures should be numbered in accordance with a sequence established by the first identification in the text of the particular table or illustration. Verify references against the original documents. Use the style of the examples approved by the National Library of Medicine, and abbreviate journal titles according to the style used in *Index Medicus*. (See also Appendix 2 [10].)

MANUSCRIPT PREPARATION

Authors should familiarize themselves with the policies and instructions of the journal to which they intend to submit an information synthesis. Journals usually publish information on what types of articles they will accept, as well as specific instructions for manuscript preparation and submission. Type all text (title, abstract, footnotes, references, etc.) double spaced; begin each section (and table) on a new page; number all pages in sequence; keep a copy of everything submitted. Submit the review to one journal at a time. Most journals only accept an article on this understanding, and on the assumption that it has not been accepted or published elsewhere.

APPENDIX

GUIDELINES FOR DEVELOPING AND CRITERIA
FOR EVALUATING AN INFORMATION SYNTHESIS

Underscored items represent particularly important criteria (major flaws if not met); capitalized items represent fatal flaws if not met. The

three-digit number given to each criterion is a hierarchical code; numbers missing from the series do not imply missing criteria.

100   *Definition*

111   IS THE PURPOSE OF THE INFORMATION SYNTHESIS DESCRIBED CLEARLY?

112   ARE THE CONTEXT AND RELEVANCE OF THE INFORMATION SYNTHESIS DESCRIBED?

121   IS THE INTENDED AUDIENCE/POTENTIAL USER DESCRIBED CLEARLY?

122   Is the purpose to which the author intends the target audience to put the information synthesis described clearly?

123   Is this purpose described in operational terms, to permit quantitative audience evaluation?

131   Is the information synthesis subject/topic identified clearly?

132   Is the definition of the subject/topic appropriate to the author's purpose of the information synthesis?

133   Is the definition congruent with generally prevailing notions?

134   If not, are the incongruities explained and reasons for them given?

141   Are the specific aspects of the subject/topic (for which information is to be synthesized) delineated clearly?

142   Are explicit criteria of relevance (particularly inclusions and exclusions) described clearly?

143   ARE CRITERIA OF RELEVANCE DEFINED IN OPERATIONAL TERMS?

144   Do the criteria of relevance flow logically from the subject/topic definition and from the delineated aspects of this definition?

200   *Collection of Information (from Paper Sources)*

211   Is the plan (strategy) used to identify relevant information (citations) described?

212   Is the scope of the citation search described (e.g., in terms of time period covered)?

213   Is the citation identification plan and its scope appropriate to the author's purpose of the information synthesis?

221   Are databases searched or sources of citations described?

222   Are unpublished citations (e.g., meeting papers, current re-
       search) included in the citation search?

223   Are experts working in the subject of the information synthesis
       included in the citation search?

231   Is the method used to identify relevant citations from source
       materials and documents described? (e.g., who applied the cri-
       teria of relevance, to what information, how?)

232   Is the method appropriate to the author's purpose of the informa-
       tion synthesis?

233   Are classifiers standardized (e.g., specially trained), and are pro-
       visions made to deal with classifier variability?

234   Are error rates stated (false positives—citations labeled relevant
       that are not, and false negatives—citations not labeled relevant
       that are)?

235   Are initial citation search error rates calculated and used to
       refine the criteria of relevance?

236   Are subsequent error rates calculated and reported?

237   Are some or all citations reclassified to estimate both inter- and
       intra-classifier variability?

241   Is the universe of relevant citations estimated?

242   Are the results of the citation search described clearly (e.g., num-
       ber of citations identified, number relevant)?

243   Is the amount of effort spent in the citation search stated?

244   ARE THE RESULTS OF THE CITATION SEARCH CON-
       SISTENT WITH THE AUTHOR'S PURPOSE OF THE
       INFORMATION SYNTHESIS?

245   With the information presented (on citation bases searched,
       etc.), could another investigator replicate or extend the informa-
       tion synthesis?

251   Is an attempt made to retrieve every relevant citation?

252   If a sample of relevant *citations* is retrieved, is the sampling plan
       described? Is it appropriate to the author's purpose of informa-
       tion synthesis?

253   Is the proportion of relevant citations retrieved given (whether or
       not a sample)?

254   Are the types of citations not retrieved described and reasons for
       nonretrieval explained?

261 Is the relevance of retrieved citations (i.e., articles or research reports) determined?

262 If a sample of articles or research reports is assessed, is the sampling plan described? Is it appropriate?

263 Is the method used to review article relevance described clearly?

264 Is the method appropriate to the author's purpose of the information synthesis?

265 Are the results of this article relevance determination stated?

271 Is each relevant research report reviewed and its content abstracted, classified, and sorted?

272 If a sample of relevant research reports is reviewed, is the sampling plan described? Is it appropriate to the author's purpose of the information synthesis?

273 Is the actual number of research reports reviewed, sorted, and classified stated?

274 Are these research reports listed or referenced explicitly?

275 Is the method used to review, classify, and sort the information content of relevant research reports described clearly?

276 Is the method appropriate to the author's purpose of the information synthesis?

281 Is a formal protocol (either criteria or a schema) used to review, classify, and sort the content of each relevant research report?

282 Are protocols pretested and revised in light of pretest results?

283 Is the pretest conducted on research reports that are part of the information synthesis?

284 Are research reports reviewed, classified, or sorted in the pretest rereviewed, reclassified, or resorted using the final protocol?

285 Is the implementation of protocols or procedures quality controlled?

291 Is the content of all relevant research reports reviewed by a group and a judgment on content obtained?

292 Is the content of all relevant research reports reviewed by the author(s), as opposed to research assistants?

293 If different reviewers each review/classify a portion of all relevant research reports, are reviews standardized (i.e., provisions made to deal with reviewer variability)?

294 Are the results of the review and classification of content of the relevant research reports described?

300 Assessment of Information/Data (Research Findings)

311 ARE THE DATA CONTAINED IN RELEVANT RESEARCH REPORTS VALIDATED (i.e., ASSESSMENT OF THE EXTENT TO WHICH THE DATA GENERATED BY THE RESEARCH ARE SUBSTANTIATED BY THE REPORTED RESEARCH METHODS USED TO GENERATE THEM)?

312 If a sample of relevant research reports is validated, is the sampling plan described? Is it appropriate to the author's purpose of the information synthesis?

313 Is the actual number of research reports validated stated?

314 Are these research reports listed or referenced explicitly?

315 Is the method used to validate research data described clearly?

316 Is the method appropriate to the author's purpose of the information synthesis?

321 Is the validation conducted according to a formal protocol?

322 Are protocols pretested and revised in light of pretest results?

323 Is the pretest conducted on research reports that are a part of the information synthesis?

324 Are research reports assessed in the pretest reassessed using the final protocol?

325 Is the implementation of protocols or procedures quality controlled?

331 Is the validation conducted by a group, so that a group judgment results?

332 Is the validation conducted by experts, as opposed to research assistants?

333 If different assessors each validate a portion of all relevant research reports, is there standardization of validations (i.e., provisions made to deal with assessor variability)?

341 Are the results of the validations described?

342 ARE RESEARCH REPORTS CONTAINING VALID DATA IDENTIFIED EXPLICITLY, OR LISTED?

351   Are data from research reports extrapolated, transported, transformed, or generalized in any way?

352   Are extrapolations, etc., or generalizations warranted, appropriate?

353   Is the method used (and the assumptions involved) described clearly?

354   Is the method appropriate to the data involved?

355   Are results of extrapolations, etc., or any generalizations, described clearly?

361   Are data extracted from research reports subjected to a meta-analysis procedure?

362   Is the meta-analysis method or procedure described?

363   Is the meta-analysis method used appropriate for the data applied to it?

364   If only selected data are subjected to a meta-analysis procedure, are the selection criteria stated?

365   Are these selection criteria appropriate to the method, data, and the author's purpose of the information synthesis?

366   Are the results of the meta-analysis described clearly?

400 Presentation

411   Are criteria used to select data for presentation stated?

412   ARE THESE CRITERIA APPROPRIATE TO THE AUTHOR'S PURPOSE OF THE INFORMATION SYNTHESIS?

413   Are all data meeting selection criteria from all relevant, valid research reports presented (as opposed to data from selected research)?

414   Are only data from the (primary) research reports gathered and validated as part of this information synthesis presented? (in contrast, for example, to inclusion of data from previous (secondary) reviews of the literature without their formal assessment?)

421   ARE RESULTS/DATA PRESENTED IN A WAY USEFUL TO THE TARGET AUDIENCE?

422   Are data presented clearly and organized in a meaningful or logical fashion?

423   Are data presented related explicitly to the criteria of relevance (subject/topic definition and aspects of interest)?

424   Are tabular arrays or graphed results presented clearly and objectively, and internally consistent?

425   ARE DATA PRESENTED SUPPORTED BY REFERENCE TO SPECIFIC RESEARCH REPORTS?

426   Is each reference cited in the information synthesis dealt with specifically in the text?

427   Are conflicting data presented? If so, what advice is provided with respect to resolving such conflicts?

431   <u>Are gaps in knowledge identified explicitly?</u>

432   Is the significance of information gaps discussed?

433   Is the feasibility and practicality of research required to generate needed but missing information assessed?

434   Are priorities for needed research discussed?

441   Are the limitations of the information synthesis discussed?

442   Are the implications of the state of the literature/information on the subject/topic discussed?

443   Are important (practical) implications that flow logically from the state of knowledge discussed?

444   Are warranted recommendations given?

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*These criteria were elaborated from: Policy Research Incorporated. Literature Review Validation Procedures Manual. Baltimore, 1979. If used to evaluate the adequacy of an information synthesis, the evaluator should answer each question with one of the following: (1) not applicable; (2) need help to evaluate; (3) yes (met); (4) not determinable; (5) no (not met) or not determinable — minor flaw; or (6) no (not met) or not determinable — major flaw (underscored and, particularly, capitalized criteria).

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9. Broad, W. J. Fraud in science taints the high and mighty. *New York Times* 1983, Mar 20:20E.
10. Huth, E. J. *How To Write and Publish Papers in the Medical Sciences.* Philadelphia: ISI Press, 1983.