Chapter 11
Writing a scientific paper

11.1 Introduction

Writing a scientific paper is the most common way of communicating the results of research to other scientists and to health professionals. It goes without saying that authors should at all times have in mind objectivity, clarity and honesty in reporting their research. The format for writing a scientific paper for publication in biomedical journals has been standardized to provide a systematic and organized way to present the data. The text of observational and experimental articles is usually (but not necessarily) divided into sections with the headings: Introduction, Methods, Results, and Discussion. Long articles may need subheadings in some sections (especially the Results and Discussion sections) to clarify their contents. Journals generally provide in each issue, and on their web sites, detailed instructions to the authors on the required format for submitting papers.

The process of writing up the research should begin during the research planning, and continue while the research is being implemented. When the results of the research are analysed, a first draft of the written paper can be produced. Revision of this draft is an important part of the process. It should include revision for the content and revision of the style.

Not all scientific communications fit into the classical format for presentation of research. Two such examples are a case report and a scientific review. There are special considerations in writing a paper describing the results of qualitative research, and also in writing a thesis or dissertation.

The International Committee of Medical Journal Editors issues a set of uniform requirements for submitting manuscripts to biomedical journals. These requirements are revised periodically, the latest version being dated November 2003. The requirements were taken into consideration in developing the guidelines in this chapter and also in Chapter 12 on publishing a scientific paper. For more details, the reader may consult the references and additional sources provided for the chapter.

11.2 Selecting a title for the paper

A good title should adequately describe the contents of the paper in the fewest possible words. It should not be too long or too short; generally, it should consist of 10–12 words. Some journals, but not all, allow sub-titles. The title should not include any unnecessary words, nor waste space with phrases such as "Observations on" or "A study of". It should not contain abbreviations.

Many journals require a running title (short title) to be printed at the top or bottom of every page of the article when it is published. Usually, this is between 30 and 50 characters.

11.3 Writing the abstract and key words

An abstract should be included at the beginning of the paper. The abstract can persuade or put off readers. The abstract is the part of the paper that will be included in most electronic databases, available for retrieval. The abstract should state the purposes of the study or investigation, basic procedures (selection of study subjects or laboratory animals; observational and analytical methods), main findings (giving specific data and their statistical significance, if possible) and the principal conclusions. It should emphasize the new and important aspects of the study or observations.

A good abstract should be a miniature version of the paper, provide a brief summary of each of the main sections of the paper and follow the structure of the paper. Many journals require a structured abstract, which includes subtitles such as objective, type of design, setting, material or subjects, methods, results, and conclusions. The number of words in an abstract should generally be less than 150 for unstructured abstracts, and less than 250 for structured abstracts. Some electronic databases are programmed to accept only up to this limited number of words. Abstracts are generally written in the past tense. The abstract should be self-contained and able to stand alone without need to consult the full text. As such it should not include references to literature or to figures and tables in the body of paper, should not include information that is not in the paper, and should not contain abbreviations or acronyms unless standard or very well known.

Most scientific journals require authors to provide 3 to 10 key words or short phrases that will assist indexers in cross-indexing the article. Key words are usually placed beneath the abstract. Terms from the Medical Subject Headings (MeSH) list of PubMed (US National Library of Medicine) should be used wherever possible, to facilitate indexing and retrieval (see Annex 3).

11.4 Article structure

A scientific article generally consists of four sections, with the acronym IMRAD: Introduction, Methods, Results, and Discussion. These sections are described by the following questions, called the Bradford Hill questions, after the author (Hill, 1965):

Introduction:	Why did the authors start?
Methods:	What did they do?
Results:	What did they find?
Discussion:	What do the results mean?

Reasoning in the paper should follow a straight line. The flow should not stray from the objective or research question. It cannot be written in the style of a story or novel, where the author can move between the characters and can jump between different time episodes.

11.5 Writing the Introduction

The introduction should:

- tell the reader why the research was started, and make clear what question the research was designed to answer. Research is not a fishing expedition. It is designed with a specific question in mind.
- raise the interest of the reader. The first few lines in the paper may attract or put off the reader. Investigators are advised to convey their enthusiasm but not to exaggerate.

The introduction should not:

- explain what can be found in any textbook in the field
- be over-referenced; it should give only strictly pertinent references
- include data or conclusions from the work being reported.

11.6 Writing the Methods section

Principles

Replicability of results is the heart of science. The methods section should provide a detailed exposition of the research design. A reader of the methods section should be able to repeat the study and to validate the findings. A methods section less than two double-spaced pages is probably inadequate.

The methods section should be organized under meaningful subheadings and describe techniques used in sufficient detail to allow others to replicate the study. Established methods should be referenced but no description is necessary. For published but not well known methods, a reference as well as a brief description should be given. New or substantially modified methods should be clearly described, with reasons given for using them and with their limitations outlined.

The methods section should not:

- refer to patients and animals as material; patients and animals are living things; not inanimate "material". The term "material" should be used only if inanimate specimens have been used.
- use proprietary names of drugs; generic names should be used.

Ethics

When reporting experiments on human subjects, authors should indicate whether the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional or regional) and with the Helsinki Declaration.

Patients' names, initials, or hospital numbers should not be used. Particular care should be taken that these do not appear in illustrative material.

When reporting experiments on animals, authors should indicate whether the institutional or national guidelines or laws on the care and use of laboratory animals were followed.

Statistics

Statistical methods should be described in sufficient detail to enable a knowledgeable reader with access to the original data to verify the reported results. References for statistical methods should be to standard works when possible. Any computer programs used should be identified. Statistical terms, abbreviations, and symbols should be defined.

Details about randomization, if used, should be given, as well as concealment of allocation to treatment groups, and the method of masking (blinding). Losses to observation (such as dropouts from a clinical trial) should be reported.

It is recommended to include the word "considered" in descriptions of statistical significance such as "a *P* value of less than 0.05 was considered statistically significant", since the choice of this cut-off point is arbitrary.

It is better to avoid non-technical uses of technical statistical terms, such as “random” “significant”, “correlation” and “sample” in non-statistical contexts.

11.7 Writing the Results

Principles

The objective of the research should be kept in mind. Results that do not relate to the research objective should not be mentioned. Sufficient detail should be given to allow other scientists to assess the validity and accuracy of the results. Statistics should not take over the paper, but statistical analysis of the results should be adequately described. Results should be presented in a logical sequence in the text, tables, and illustrations. Tables and graphs are often extremely helpful in summarizing large amounts of data. Authors should not repeat in the text the numerical data contained in figures and tables.

The number of tables and figures should be restricted to those needed to explain the argument of the paper and to support its findings. A good rule about whether to include figures or not is: When in doubt, leave it out.

Tables

Tables should be used to show the exact values of more data than can be summarized in a few sentences of text; or when the objective of presenting data is to present specific inter-relationships. Tables should not be used when the data can be easily presented in the text (tables are more expensive to typeset than text); or when there is no relation between the data or to a time sequence.

A table should be readily understood without reference to the text. After reading the title and abstract, many readers often glance through the tables and illustrations before deciding whether or not to read the text. A table should be cited in the text, be numbered, and have a title which exactly describes the content of the table. It should have short or abbreviated headings for columns and rows and, if necessary, a footnote for explanation of non-standard abbreviations that are used, and for identification of statistical measures of variations, such as standard deviation and standard error of the mean. Tables should have a logical structure. Columns should be arranged from left to right in a logical sequence, e.g. to reflect the sequence in which data were collected or changes over time. Rows should be arranged from top to bottom in a logical order, e.g. by ascending order of age.

A table should not include in its title any unnecessary words, nor a repetition of column and row headings. There should be no ambiguity about the purpose of the

columns and rows. When column headings are grouped, a straddle-line should be used to eliminate any uncertainty about which column headings are included under the grouped column headings. Items in row headings may be indented to indicate groupings.

For purposes of publication:

- The table should not exceed the width of the journal columns. A single-column table, in a journal with a double-column page, should not include more than 60 characters (and equivalent spaces) in a row (with its row heading). A table running the full width of a page should not include more than 120 characters in a row.
- Each table should be typed or printed with double-spacing on a separate sheet of paper. Tables should not be submitted as photographs or images.
- Tables should not have internal horizontal and vertical rules.
- Tables should be numbered consecutively in the order of their first citation in the text. Each table should be cited in the text.
- If data are used from another published or unpublished source, permission is needed and should be acknowledge fully.
- The use of too many tables in relation to the length of the text may produce difficulties in the layout of pages. Issues of the journal to which the paper will be submitted can be checked to estimate how many tables can be used per 1000 words of text. A general rule is no more than one table (or illustration) per 1000 words of text (4 pages of manuscript).
- The editor, on accepting a paper, may recommend that additional tables containing important backup data, too expensive to publish, be deposited with an archival service, such as the National Auxiliary Publication Service in the United States, or made available by the author on request. In that event an appropriate statement will be added to the text. Such tables should be submitted for consideration with the paper.

Illustrations

Illustrations should be used only for a specific purpose. An illustration may be used as evidence to support the argument, since "seeing is believing". Illustrations may be used as a more efficient way in presenting data. A flow chart is such an example. The use of illustrations for emphasis, just to stress a point, is not a good purpose. It may be more appropriate for a presentation than a written paper.

Graphs are used to illustrate relationships. If exact values are important, a table is preferable to a graph; when trends and relationships are more important than exact

values, a graph is more efficient. A graph is a better alternative than a table with many entries. The same data should not be repeated in figures and tables.

For purposes of publication:

- Figures should be professionally drawn and photographed; freehand or typewritten lettering is unacceptable.
- Instead of original drawings, X-ray films, and other material, authors should submit sharp, glossy, black-and-white photographic prints, usually 127 × 173mm (5 × 7 inches) but not larger than 203 × 254mm (8 × 10 inches). Letters, numbers, and symbols should be clear and even throughout, and of sufficient size that when reduced for publication each item will still be legible.
- Titles and detailed explanations belong in the legends for illustrations not on the illustrations themselves.
- Each figure should have a label pasted on its back, indicating the number of the figure, author's name, and top of the figure. Do not write on the back of the figures or scratch or mar them by using paper clips. Do not bend figures or mount them on cardboard.
- Photomicrographs should have internal scale markers. Symbols, arrows or letters used in microphotographs should contrast with the background.
- If photographs of people are used, either the subjects must not be identifiable or their pictures must be accompanied by written permission to use the photographs.
- Figures should be numbered consecutively according to the order in which they have been first cited in the text.
- If a figure has been published, the original source has to be acknowledged and a written permission from the copyright holder to reproduce the material should be submitted.
- Permission is required irrespective of authorship or publisher except for documents in the public domain.
- For illustrations in colour, it is important to ascertain whether the journal requires colour negatives, positive transparencies or colour prints. Some journals publish illustrations in colour only if the author pays for the extra cost.
- Legends for illustrations should be typed or printed using double spacing, starting on a separate page, with Arabic numerals corresponding to the illustrations.
- When symbols, arrows, numbers, or letters are used to identify parts of the illustrations, each one should be explained clearly in the legend. The internal scale, and the method of staining in microphotographs, should be stated.

11.8 Writing the Discussion and Conclusions

This section of the paper should emphasize the new and important aspects of the study and the conclusions that follow from them. It should not repeat in detail data or other material given in the Introduction or Results sections.

Good papers have a targeted discussion, to keep it focused. The discussion should preferably be structured to include the following six components (Docherty and Smith, 1999):

- statement of principal findings
- strengths and weaknesses of the study
- strengths and weaknesses in relation to other studies
- meaning of the study, possible mechanisms and implications for clinicians and policymakers
- unanswered questions and future research
- conclusion.

- Statement of principal findings: The opening of the discussion usually gives the answer to the research question, or a restatement of the principal findings. This should not normally be more than a few sentences. It is advisable that the discussion start with a sentence that clearly shows that the paper includes new information. Reviewers often start with a "null hypothesis" that the paper does not add anything new.
- Strengths and weaknesses of the study: Equal emphasis should be given to both strengths and weaknesses. Reviewers are more interested in seeing that the author is aware of the weaknesses. If the reader discovers in the paper weaknesses that are not mentioned by the author, the trust in the paper will be shaken. A subheading such as "limitations of the study" or data is useful. Findings that have not been described in the results section should not be discussed.
- Strengths and weaknesses in relation to other studies: All evidence bearing on the argument, with or against, should be considered. Authors should discuss the opposing point of view, taking a "devil's advocate" position. Full credit should be given for supporting evidence. Authors should avoid burying the citation of a previously published paper on the same question, which arrived at the same answer in the discussion. Such a citation is better highlighted in the introduction. It is not enough to simply summarize published papers. The authors should critically evaluate their methodology, findings and conclusions. In particular, any differences in results should be discussed and possible explanations offered. If the authors do not know why their results are different from other studies, they should say so, but not imply that their results are better.

- Meaning of the study, possible mechanisms and implications for clinicians and policymakers: This section should be written carefully. Authors should not move beyond the limited evidence provided by the study. Restraint in stating implications is a virtue appreciated by reviewers and readers. It may also be relevant to emphasize, not only what the results mean, but also what the results do not mean. This will keep readers from making unjustified conclusions.
- Unanswered questions and future research: New research may be proposed to provide the answer to questions that are still not answered. A good study should generate new ideas for further research. A simple statement that further research is needed is less helpful than providing new specific research questions or suggesting particular studies.
- Conclusion: A good paper ends with strong clear conclusions. It has been said that the body of a good paper is a "thunderbolt in reverse": it begins with thunder (introduction) and ends with lightning (conclusions) (Byne, 1998). Conclusions should be linked with the goals of the study, and should be limited to the boundaries of the study. Authors should avoid unqualified statements and conclusions not completely supported by the data. For example, they should not make statements on economic benefits and costs unless their manuscript includes economic data and analysis. Authors should refrain from claiming unjustified priority about the findings. It should be noted that a negative finding could be as important as a positive finding.

11.9 Acknowledgements

At an appropriate place in the article (the title page, footnote or an appendix to the text; depending on the journal requirements), one or more statements should specify: contributions that need acknowledging but do not justify authorship, such as general support by a department chair; acknowledgement of technical help; acknowledgements of financial or material support, which should specify the nature of the support; and relationships that may pose a conflict of interest.

Persons who have contributed intellectually to the paper but whose contributions do not justify authorship may be named and their function or contribution described, for example "scientific adviser", "critical review of study proposal", "data collection", or "participation in clinical trial". Such persons must have given their permission to be named. Authors are responsible for obtaining written permission from persons acknowledged by name, because readers may infer their endorsement of the data and conclusions. Technical help is better acknowledged in a paragraph separate from that acknowledging other contributions.

11.10 Citation of references

The reference section is an important part of a scientific paper. The number of references should be restricted to those that have a direct bearing on the work described. Except for review articles, it is rarely necessary to have more than 40 references in the longest paper (Halsey, 1998).

References should be carefully checked. They should be verified against original documents. One study has shown that in a random check of references in published papers, 20% were misquoted, with half of the misquotations being seriously misleading (DeLacey et al. 1985). Useful advice for the author is to photocopy the first page of every reference cited. This page normally includes all the information needed for correctly citing the reference.

Different standard formats for citing references are used in different scientific disciplines. These formats include: MLA Style established by the Modern Language Association; APA Style, governed by the Publication Manual of the American Psychological Association; CMS Footnote Style, conforming to the Chicago Manual of Style; and CBE Number Style established by the Council of Biology Editors.

In biomedical sciences, there are two major styles for citing the references: the Harvard system and the Vancouver system.

In the Harvard system, the order of references at the end of the paper is strictly alphabetical, regardless of the chronology. In the text of the paper, references are cited by giving in parentheses the name of the author and the year of publication. When the author's name is part of a sentence, only the year is put in parentheses. When several references are given together, they should be listed in chronological order and separated by a semicolon. When a paper written by two authors is quoted, both names are given. If there are more than two authors, all the names may be given the first time the reference is cited. Otherwise, it is sufficient to give the name of the first author only, adding "et al". The term "et al" means "and others". It is an abbreviation for two Latin terms: "et alii" (masculine) and "et aliae" (feminine). When two citations have the same author and the same year of publication, alphabetical annotation is used, for example "2004a". The order of these alphabetically annotated citations ideally should be chronological within the year.

The Vancouver system has been adopted in the "Uniform Requirements for Manuscripts Submitted to Biomedical Journals" by the International Committee of Medical Journal Editors (who held their first meeting in Vancouver). Most biomedical journals follow this system. It is based largely on a standard style adapted by the US National Library of Medicine (NLM) for its databases. According to the Vancouver style, references should be numbered consecutively in the order in which they are first mentioned in the text. References in text, tables and legends should be identified by

Arabic numerals in parentheses. References cited only in tables or figure legends should be numbered in accordance with the sequence established by the first identification in the text of the particular table or figure.

In writing the early drafts of the paper, it is advisable to use the Harvard style. If numbers are assigned to references at this early stage, those numbers will very likely have to be changed in subsequent drafts. In the final draft, the authors can switch to the Vancouver style. To track the references in the early drafts using a word-processing program, one can place at the beginning of each citation a character not used elsewhere in the text, for example an asterisk (*).

If journal titles are abbreviated, as is the practice in most but not all journals, this should be in line with the abbreviations in the Index Medicus (which are based on an international standard). The list of journals is published annually in the January issue. The list can also be accessed through the web site of the US Library of Medicine (http://www.nlm.nih.gov).

Unpublished observations are generally not to be used as references; papers accepted for publication but not yet published and given as references are identified as "in press" or "forthcoming"; research papers submitted to a journal but not yet accepted are to be treated as unpublished observations.

Authors should avoid citing a "personal communication" unless it provides essential information not available from a public source, in which case the name of the person and date of communication should be cited in parentheses in the text. Authors should obtain permission and confirmation of accuracy from the source of a personal communication.

Annex 4 provides examples on how different types of references should be cited. Additional information may be obtained from the web site: http://www.nlm.gov/bsd/uniform_requirements.html.

11.11 Steps in the process of writing a paper

The process of writing a scientific paper should start before doing the research, continue during the research, and be completed after the research results have been described, analysed and interpreted. After writing the paper, it should be carefully revised, first for content and then for style.

Before the research

- Search the literature and keep a record of the references.
- Prepare dummy tables for results.

During the research

- Record the results.
- Update the literature.

After completion of the research

- Use a systematic approach, building the paper step by step. Do not try to do the whole thing at once.
- Start with an outline, which will serve as framework.
- The discussion is the part that requires most careful thought and interpretation.
- Begin with the easiest section. Deal with individual sections one at a time.
- Decide on the journal to which the article will be submitted and study its format requirements.
- Write the rough draft: Once you start, write as fast as you can. Do not worry about style.
- Put the paper aside for several days or weeks and then re-read it.
- Give a version of the paper to a colleague or colleagues to review it.
- Date all drafts.

11.12 Revision of the manuscript for scientific content

For creative writing, the word processor is the best invention since the quill pen. The days of retyping are over. Most journals require an electronic copy of the paper.

Revision checklist

- Is the title accurate, succinct and effective?
- Are keywords indexable? It is better to use keywords from the Medical Subject Headings (MeSH vocabulary) of MEDLINE (Annex 3).
- Does the abstract represent the content of all the main sections of the paper, within the length allowed by the journal? Do data in the abstract agree with data in the paper?
- Does the introduction set the stage adequately but concisely for the main question considered, or for the hypothesis tested, in the paper? Is that question or hypothesis made clear by the end of the introduction?
- Are the methods described in enough detail to allow replication of research? Are statistical methods described?

- Are the results presented in a way that allows other investigators to check and to compare? Can any of the tables or illustrations be omitted? Can any of the tables be replaced by a graph? Do data in the text agree with data in the tables? Are all tables and figures cited in the text? Are all tables and figures mentioned in the text included? Are legends of figures correct?
- Does the discussion properly interpret the significance of the data? Does the discussion reflect up-to-date awareness of the literature? Are conclusions justified by the results?
- Are all references cited mentioned in the text? Are all references mentioned in the text cited? Have any necessary references been omitted?
- Is the length of the paper appropriate? Does any of the text repeat information found elsewhere in the paper? Are there paragraphs or sentences that can be omitted? Where possible, it is good to plan to submit an article that is shorter than the average article published in the journal to which the paper will be sent. The best papers are concise. Generally, a manuscript should, on average, be about 10 double-spaced pages, or 3 published pages, with 25 references. (Each printed page is about 3–4 double-spaced typed pages). The sections of a manuscript that are often too long are the introduction and discussion. The sections that are often too short are the methods and results. A good rule is to shorten the introduction and discussion and to expand the methods and results sections.
- Are all pages numbered?

11.13 Revision of the manuscript for style

The acronym "KISS", "keep it simple and short", is the key to good scientific writing. Authors should always choose the simplest and shortest way of saying something. It takes more time to write a good concise paper, than a lengthy one. Pascal once wrote to a friend: "I am sorry this letter is so long but I had no time to write a short one." Most authors do not spend enough time planning. Good planning will shorten the time spent in writing.

In editing oneself, consideration should be given to paragraphs, sentences and words. The following sections provide a few useful hints, particularly for non-English speakers. For additional information, sources such as Strunk (2000) can be consulted.

Paragraphs

Well structured paragraphs are the key to good writing, and should consist of: a topic or lead sentence to introduce the subject of the paragraph; body sentences which expand upon the theme and present a logical argument; and either a transitional sentence,

which leads into the next paragraph, or a concluding sentence. There is no firm rule on paragraph length: more than 25 typed lines would be too long; fewer than 5 or 6 lines represent what is really a fragment of either adjacent paragraph. A new paragraph must either link to that preceding it and/or following it, or should clearly introduce a new subject. In a long discussion, subheadings are a good idea.

Sentences

The following hints may be helpful to authors in revising the style of their paper.

- Long sentences (more than two typewritten lines) are better avoided if possible.
- The active is preferable to the passive because it is much clearer and easier to understand, in general. For example, replace "It was found by *x*" by "*x* found that"). The passive voice has traditionally been used in scientific writing to refer to the thoughts or actions of the author. This tendency is slowly changing, and many editors now encourage authors to use "I" or "we" in their writing.
- Avoid ambiguity in the use of adjectival and adverbial clauses and phrases. It is often better to simplify sentences by splitting the subordinate phrases and clauses and making them sentences on their own.
- Avoid verbosity (to say a thing in a complicated way, to make it sound important) or pompous verbiage.
- Each sentence must have a verb, and the verb should agree with the noun.
- Economy is a virtue. Strike out unneeded words and phrases.
- "Do not use a preposition to end a sentence with"—is a good rule which itself breaks the rule.
- It is a useful convention to put anything that was done in the past tense and to put general statements in the present tense. In general, the introduction and discussion sections are written in the present tense, and the methods and results sections are written in the simple past tense.

Words

It is advisable to look for and try, where possible, to replace the following six groups of words.

- Abstract nouns (nouns formed from verbs and ending in: tion, sion, ance, ment, ness, cy). These nouns are better replaced with verbs. For example, change "Measurements were performed on the variation" to "The variation was measured" or "we measured

the variation"; change "The interpretation of the data was made" to "Data were interpreted" or "we interpreted the data".

- Compound nouns (noun clusters) e.g. patient liver enzyme status (the status of liver enzymes in patients); research result dissemination methods (methods of disseminating research results).
- Abbreviations, unless they are standard and unless they are used at least ten times in the paper. Avoid abbreviations in the title and abstract. The complete term for which an abbreviation stands should precede its first use unless it is a standard unit of measurement.
- Sexist words: Do not use the pronoun "he" or "his" when she or her would be equally appropriate. Use the plural form instead. Try to replace words such as: man (unless referring to a man), mankind, manpower, policeman, foreman.
- Dehumanizing words: e.g. referring to people as cases or subjects (use patients or volunteers for example); using syndromic tags for patients; male/female are more appropriate for animals; men and women are better for human subjects.
- Slang and jargon (words that have an arbitrary meaning).

Do not confuse American and British Spelling. Follow the style prescribed by the journal. If in doubt, use a good dictionary (do not depend on the spell-checker in the computer which is only as good as its content).

Unless otherwise requested in the journal instructions to authors:

- Measurements of length, height, weight, and volume should be reported in metric units (metre, kilogram, or litre) or their decimal multiples, and temperatures should be given in degrees Celsius. Blood pressure should be given in millimetres of mercury.
- All haematological and clinical chemistry measurements should be reported in the metric system in terms of the International System of Units (SI). Editors may request that alternative or non-SI units be added by the authors before publication.

11.14 Writing a case report

Reports of single cases have become less and less acceptable for publication in major journals, mainly because of their tendency to carry relatively little important new information. The following kinds of case reports still merit publication:

- The unique or nearly unique case that appears to represent a previously undescribed syndrome or disease.

- The case with an unexpected association of two or more diseases or disorders that may represent a previously unsuspected causal relation.
- The case representing a new and important variation from an expected pattern: the "outlier" case.
- The case with an unexpected evolution that suggests a therapeutic or adverse drug effect.

A good example of an important case report is the report by Hymes et al. in 1981 of eight cases of the rare skin tumour, Kaposi's sarcoma in New York. Usually a slowly growing tumour, the course in these cases was aggressive. Usually a disease of old people, these cases occurred in young men. The patients were all homosexual men. This report first alerted the world to the AIDS epidemic.

11.15 Writing a secondary scientific paper

A secondary scientific paper is a review paper which summarizes other papers. There are two types of reviews: a narrative review and a systematic review. The distinction between the two types of review should be clear. Meta-analysis is a special type of systematic review.

Narrative review

In the narrative review, the studies reviewed have not been identified or analysed in a systematic, standardized and objective way. Experts, to provide an update on a certain subject, usually write the review.

Systematic review

The systematic review contains an explicit statement on objectives with a spelt out research question. The data sources for the papers (including grey literature) are stated as well as the method of selection. The review is conducted according to an explicit and reproducible methodology. Different from the narrative review generally written by experts, a systematic review may be better done by non-experts on the subject, who are experts on writing systematic reviews.

A systematic review generally includes the following parts:

- Abstract
- Introduction: A well-conceived systematic review answers a question or closely related questions, which should be made clear at the beginning of the review.

- Methods: The methods section in a systematic review should fully describe the methods used for locating, selecting, extracting and synthesizing the data. It should outline the literature search, including the bibliographic indexes and databases searched, limits on years and languages, as well as search terms used.
- Body of the review: Topics in the body of the review depend on subject. The sequence should have a logical basis. Sequence should be made clear by subheadings. The argument should be critical.

Assessment of the quality of systematic reviews is discussed in Chapter 14.

Meta-analysis/pooling

Meta-analyses critically review research studies and statistically combine their data to help answer questions that are beyond the power of single papers. "Power" is the term to describe the value of this technique. Combining data from a number of studies increases the sample size. The technique of meta-analysis has great potential for synthesizing research results and adding precision and power to our estimates of effect.

The results of these meta-analyses now tend to be presented in a standard format, because they mostly use a common computer software known as MetaView to do the calculation and express the results in a graphic form. This format is colloquially known as a "forest plot" or "blobbogram". It shows a number of horizontal lines, each representing one study. The blob in the middle of each line is the point estimate, and the width of the line represents the 95% confidence interval of this estimate. A vertical line represents "line of no effect". If the horizontal line of any trial does not cross the line of no effect, there is a 95% chance that there is a "real" difference between the groups (Greenhalgh, 1997).

A typical example of the value of meta-analysis studies is the meta-analysis of seven trials of the effect of giving steroids to mothers who were expected to give birth prematurely. Only two of the seven trials showed a statistically significant benefit. But when the results of the seven studies were pooled together, the strength of the evidence in favour of the intervention was demonstrated. The meta-analysis showed that infants of mothers given corticosteroids were 30% to 50% less likely to die. The Cochrane Collaboration adopted this example as its logo (Greenhalgh, 1997).

Assessment of the quality of meta-analysis is discussed in Chapter 14.

11.16 Writing a paper on qualitative research

Since the 1990s, qualitative methods of research have been increasingly used in health research. This has led to a corresponding rise in the reporting of qualitative research studies in medical and related journals. The following are examples of papers on qualitative research studies recently published in the *British Medical Journal*:

- Patients' views about taking anti-hypertensive drugs
- Young women' s accounts of factors influencing their use and non-use of emergency contraception: in-depth interview study
- Patients' unvoiced agendas in general practice consultations: qualitative study
- A qualitative study of evidence-based leaflets in maternity care
- A qualitative study of barriers to uptake of services for coronary heart disease
- Why do general practitioners prescribe antibiotics for sore throat? Grounded theory interview study.
- Doctor's perceptions of palliative care for heart failure: focus group study
- Knowledge and perceptions of general practitioners about impaired glucose tolerance
- Why general practitioners do not implement evidence: qualitative study
- Relation between private health insurance and high rates of Caesarean section: qualitative and quantitative study
- Qualitative analysis of psychosocial impact of diagnosis of *Chlamydia trachomatis*

Writing a paper based on qualitative research does not need to differ from the framework used for quantitative research: introduction, methods, results and discussion (Kirsti, 2001). Quotes from participants are often used in the Results section of papers on qualitative research. These should not repeat what is in the text. It is not necessary to include more than one quote to illustrate a point. In translating quotes to English, this should be done in appropriate style, reflecting the sense of the quote, and not just a literal translation. As a general rule, authors should use verbatim quotes, wherever possible, and keep them down to short segments of text.

11.17 The dissertation or thesis

Different from a scientific paper submitted for publication, a dissertation or thesis is written and submitted as a partial or complete requirement for an academic degree,

a master or a doctorate. The thesis is meant to: present and defend the results of a scientifically sound piece of research; display good knowledge of the field of study; show familiarity with the scientific method; and demonstrate the intellectual ability of the candidate. The simple acquisition of voluminous data is not enough. In most cases, this acquisition could have been done equally well by a technician.

The steps in the preparation of a thesis follow the same lines outlined in previous chapters on what research to do, planning of the research and selecting a research design, writing the research protocol, implementing the study, describing and analysing the results, and their proper interpretation. Writing the thesis also follows the same guidelines and format for writing a research paper. Although space is not a constraint, brevity is always a virtue. The following are some additional remarks for the different sections.

The introduction is generally expanded or replaced by a comprehensive review of the literature. This review is meant to display not only good and up-to-date knowledge of the field, but also the intellectual ability of the candidate. It should not include information already available in textbooks. It should include only information relevant to the work done. It should be analytical and critical. It should show the ability of the candidate to synthesize and put together information from different sources. It should properly recognize the work of previous researchers.

The objectives should be carefully stated. The thesis will be judged against how each objective was achieved.

The information in the methods section should be adequate to allow other researchers to replicate the study. Already established methods do not need to be described in any detail. Quality control of the measurements should be explained.

The results section should give equal emphasis to negative and positive findings, and should be presented in adequate detail to allow other investigators to replicate the findings.

Discussion should be limited to the results of the study. The limitations of the study should be brought up. Conclusions should not go beyond what the candidate did and found.

Acknowledgements should be generous and give credit to all who have helped the investigator.

It is not the number of references that matters but their relevance. They should include original articles and not be largely based on reviews. They should be up to date, indicating that the candidate was following the literature during and after the study. References from national sources or regional sources should be included together with those from the international literature. It is assumed that the candidate has read all the references. The references should be carefully checked against original documents.

The thesis should be checked for style. Spelling and grammar mistakes indicate sloppiness on the part of the candidate, and may lead the examiner to suspect sloppiness in the work itself. Word processors can help the candidate to recognize and correct these mistakes but contain hidden dangers and should not be relied on blindly.

In presenting the thesis, the same guidelines for scientific presentations outlined in the next chapter should be followed. Unlike a presentation to a scientific meeting, questions to the candidate will take more than the time of the presentation. The candidate has to explain his/her findings and display general knowledge in the field. Defending the work does not mean trying to cover up weaknesses in the study.

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