Writing the Abstract

Overview

Topics to be covered in this chapter include

- Purpose of the abstract
- Content of the abstract
- Strategies for writing abstracts

Purpose of the Abstract

An abstract provides a concise summary of an article and serves as a "sales tool" for that article. As the summary, the abstract must accurately reflect the article's most important points as well as the importance of the study. To readers who read an abstract but do not have immediate access to the rest of the article (for example, readers who read an abstract on Medline), the abstract must make sense by itself.

An abstract must also "sell" the article. Because an abstract is usually the first part of an article that readers scan, it must—in just a few words—make readers want to learn more about the study.

Content of the Abstract

Like an article, the abstract contains descriptions of a study's background and its hypothesis or purpose, the methods, the results, and the conclusions. Some abstracts actually contain these subheadings. Those abstracts are called *structured abstracts.* Because the length of an abstract is limited (typically to 200–250 words; about 1 double-spaced page), only the most important information can be included. Furthermore, information not stated in the main body of the article must not be included in the abstract.

Always check the author instructions of the journal to which you are submitting your article; requirements for abstracts vary from 1 journal to another.

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Note: The use of abbreviations in abstracts should be limited, and all abbreviations should be defined at first mention (in the abstract and then again in the body of the article).

Most abstracts include the elements listed below. The suggested number of sentences is shown after each element.

- Background
  - Rationale for study, including gap in knowledge *(1 or 2 sentences)*
  - Hypothesis or purpose statement *(1 sentence)*
- Methods *(usually 1 to 3 sentences)*
- Results *(usually 3 or 4 sentences)*
- Conclusions, including implications *(1 or 2 sentences)*

To construct your abstract, write a sentence or sentences for each element, in the order shown. (**Tip:** You can sometimes use sentences from the main body of your article instead of writing new sentences.) Details about each element are given below.

Background/Hypothesis

The first few sentences of your abstract should give the basic background information that led to the development of your study, including the rationale. Be sure to mention the gap in knowledge that your study was designed to fill. Clearly state the hypothesis or purpose of the study. This statement should be as specific as possible and should mirror the hypothesis or purpose statement given in the Introduction section of the article. (In fact, the hypothesis or purpose statement in the abstract can be identical to the hypothesis or purpose statement in the Introduction.)

Methods

The methods section of an abstract describes the experimental approach used and explains what was done to achieve the stated purpose. In a basic science article, describe the materials used (for example, cell lines) and kinds of experiments conducted, in chronological order, and tell what each was designed to show. In a clinical article, describe the patients, interventions, and primary end points of the study. Do not use brand names of equipment, reagents, or drugs unless your study was designed to test or compare specific brands. Use generic names instead.

Experiments and interventions are usually described only briefly, to save space. However, be sure to include a method for each result presented in your abstract. Working backward from the results in your abstract can help you determine what methods to include. Also, be sure to specify which techniques you used. For example, rather than simply saying that you analyzed protein levels, which can be done by more than one technique, it is more informative to specify that you performed Western blotting.

Results

The next few sentences of the abstract should state your most important findings. Be sure to give a result for each method described in the abstract. The results can be summarized using mean or median values, if appropriate, but should be described in enough detail to support your conclusion. As with the methods, working backward (in this case, from your conclusion) can help you determine what results to include.

Conclusions

The final sentences of the abstract should state the conclusions drawn from your most important results and the implications of your results. (It is not enough to just summarize your results.) The conclusions must be supported by the results described in the abstract and should relate to your study's hypothesis or specific purpose. The chapter "Writing the Discussion Section" describes how to identify and state the implications of your findings. Please ensure that the conclusions and implications of your study in the conclusion section of your abstract are the same as the conclusions and implications stated in your Discussion section. (The statements about the implications in the 2 parts of the paper do not have to match word for word but should be consistent.)

Activity 1

Stating an Abstract's Conclusions and Implications

The abstract on page 6-9 contains all the information needed to write the Conclusions section. Read the entire abstract and write 1 sentence stating the study's conclusions and 1 sentence stating an implication of the conclusions. A possible solution will be handed out after the discussion.

Examples of Well-Written Abstracts and Abstracts Needing Improvement

At the end of this chapter are 2 abstracts, each with a poorly written version ("Example of an Abstract Needing Improvement [Basic Science Study]" and "Example of an Abstract Needing Improvement [Clinical Study]") and a revised version ("Example of a Well-Written Abstract [Basic Science Study]" and "Example of a Well-Written Abstract [Clinical Study]"). How the well-written examples fit the model of a good abstract is indicated on each well-written example, and how the other examples could be improved is indicated on them.

Strategies for Writing Abstracts

Many people write the abstract last; with this approach, you can choose the most important sentences from the article, put them together, and then polish the final product. Some people write the abstract first and then expand it into the rest of the article. (If you write the abstract first, be sure to check it carefully after the article has been written—information in a manuscript often changes between the first draft and the final version.)

Using the structured abstract format when you are drafting your abstract will help ensure that you include all the required elements and present them in the correct order. This format also helps readers who wish to scan rapidly for the most important information. You can remove the headings later if they are not used by the particular journal to which you plan to submit your article.

Activity 2

Writing the First Draft of Your Abstract

Please write either a draft of no more than 250 words or an informal outline for the abstract of a paper on your current research. Use the structured abstract format with the following subheadings: Background, Methods, Results, and Conclusion. Be sure to clearly state your hypothesis or purpose statement, and remember to briefly state the implications of your results at the end of the abstract. We will discuss 1 or more in class if time is available. If yours is not discussed, we will be happy to review it after class. Please put your name on it and give it to an instructor.

Example of an Abstract Needing Improvement (Basic Science Study)

The following abstract could be improved:

Prostate cancer is a leading cause of death in the United States. However, the underlying cause of this disease is poorly understood. Inorganic arsenic is a toxic metalloid long known to be carcinogenic to humans, especially to tissues such as lung, skin, bladder, and liver. Several previously published epidemiologic studies have shown an association between arsenic exposure and prostate cancer. This study was designed to determine whether the nontumorigenic human prostate epithelial cell line RWPE-1 could be malignantly transformed in vitro by arsenite. RWPE-1 cells were derived from normal human prostate epithelium, were immortalized with human papillomavirus 18, and are nontumorigenic. RWPE-1 cells were continuously exposed to 5 μM arsenite and monitored for signs of transformation, assessed as changes in matrix metalloproteinase-9 levels. For up to 29 weeks, cells were cultured continuously in keratinocyte serum-free medium supplemented with 50 μg/ml bovine pituitary extract, 5 ng/ml epidermal growth factor, antibiotics, and 5 μM sodium arsenite. Parallel cultures maintained in arsenite-free medium served as passage-matched controls. Cells were passaged weekly, with new cultures seeded with 1×10^6 cells in 75-cm^2 flasks. After 29 weeks of exposure, the arsenite-exposed RWPE-1 cells (referred to as CAsE-PE cells) showed a marked increase in matrix metalloproteinase-9 secretion, a common finding in prostate malignancies. Malignant transformation was confirmed when CAsE-PE cells produced aggressive undifferentiated malignant epithelial tumors in nude mice. Within 10 weeks, 5 of 5 mice inoculated with the CAsE-PE cells developed tumors, whereas none of 5 mice inoculated with the control RWPE-1 cells developed tumors ($P = 0.008$). The tumors stained positive for human prostate-specific antigen on histopathologic examination, thus confirming their origin. Thus, our results show that RWPE-1 cells showed a marked increase in matrix metalloproteinase-9 secretion.

Adapted from the well-written abstract in Achanzar WE et al. Inorganic arsenite-induced malignant transformation of human prostate epithelial cells. J Natl Cancer Inst 94:1888–1891, 2002.

Example of a Well-Written Abstract (Basic Science Study)

The following abstract is well written:

Although several epidemiologic studies have shown an association between arsenic exposure and prostate cancer, it is still not known whether human prostate epithelial cells are directly susceptible to arsenic-induced transformation. This study was designed to determine whether the nontumorigenic human prostate epithelial cell line RWPE-1 could be malignantly transformed in vitro by arsenite. RWPE-1 cells were continuously exposed to 5 μM arsenite for up to 29 weeks and monitored for signs of transformation. Increase in matrix metalloproteinase-9 levels, a common finding in prostate malignancies, was considered indicative of transformation. The arsenite-exposed RWPE-1 cells (referred to as CAsE-PE cells) were then injected into nude mice, which were monitored for tumor growth for 10 weeks. To confirm the origin of resulting tumors, tumor sections were stained for human prostate–specific antigen by immunohistochemical analysis. After 29 weeks of exposure, the CAsE-PE cells showed a marked increase in matrix metalloproteinase-9 secretion. Malignant transformation was confirmed when CAsE-PE cells produced aggressive undifferentiated malignant epithelial tumors in nude mice. The tumors stained positive for human prostate–specific antigen, confirming their origin. Thus, RWPE-1 cells can be malignantly transformed by arsenite. This is the first report of arsenite-induced malignant transformation of a human epithelial cell line, and our study provides an important in vitro model for identifying the mechanisms underlying arsenic-induced carcinogenesis in humans.

Adapted from Achanzar WE et al. Inorganic arsenite-induced malignant transformation of human prostate epithelial cells. J Natl Cancer Inst 94:1888–1891, 2002. Reprinted with permission.

Example of an Abstract Needing Improvement (Clinical Study)

The following abstract could be improved:

BACKGROUND: Colorectal cancer is associated with high mortality. We examined the effects of daily aspirin use on the incidence of colorectal adenomas.

METHODS: Between May 15, 1993, and January 10, 2000, patients ranging in age from 30 to 80 years with a history of colorectal cancer were enrolled in the trial. We randomly assigned the 635 eligible patients to receive either aspirin at a daily dosage of 325 mg or placebo. Colonoscopy was performed at recommended intervals or as determined by each patient's own gastroenterologist. Relative risks were adjusted for age, sex, cancer stage, the number of colonoscopic examinations, and the time to a first colonoscopy. The study was terminated early by an independent data and safety monitoring board when statistically significant results were reported during a planned interim analysis.

RESULTS: A total of 517 randomized patients had at least 1 colonoscopic examination a median of 12.8 months after randomization. The mean (± standard deviation) number of adenomas was lower in the aspirin group than in the placebo group (0.30 ± 0.87 vs. 0.49 ± 0.99; $P = 0.03$ by the Wilcoxon test). The median size of the largest polyp was similar in the placebo group and the aspirin group (4.0 and 3.5 mm, respectively; $P = 0.85$ by the Wilcoxon test). The adjusted relative risk of any recurrent adenoma in the aspirin group, as compared with the placebo group, was 0.65 (95% confidence interval, 0.46–0.91). The time to the detection of a first adenoma was longer in the aspirin group than in the placebo group (hazard ratio for the detection of a new polyp, 0.64; 95% confidence interval, 0.43–0.94; $P = 0.022$).

CONCLUSIONS: Aspirin treatment seems to prevent colorectal cancer.

Adapted from the well-written abstract in Sandler RS et al. A randomized trial of aspirin to prevent colorectal adenomas in patients with previous colorectal cancer. N Engl J Med 348:883–890, 2003.

Example of a Well-Written Abstract (Clinical Study)

The following abstract is well written:

BACKGROUND: Previous prevention trials suggest that regular aspirin use decreases the risk of colorectal adenomas, the precursors to most colorectal cancers, but those studies were conducted in average-risk subjects. We conducted a randomized, double-blind trial to determine the effect of aspirin on the incidence of colorectal adenomas in a high-risk group of patients, namely, those with a history of colorectal carcinoma.

METHODS: We randomly assigned patients with previous colorectal cancer to receive either aspirin at a daily dosage of 325 mg or placebo. Colonoscopy was performed at recommended intervals or as determined by each patient's own gastroenterologist. We determined the proportion of patients with adenomas, the number of recurrent adenomas, and the time to the development of an adenoma between the time of randomization and subsequent colonoscopic examinations. Relative risks were adjusted for age, sex, cancer stage, the number of colonoscopic examinations, and the time to a first colonoscopy. The study was terminated early by an independent data and safety monitoring board when statistically significant results were reported during a planned interim analysis.

RESULTS: A total of 517 randomized patients had at least 1 colonoscopic examination a median of 12.8 months after randomization. One or more adenomas were found in 17% of patients in the aspirin group and 27% of patients in the placebo group ($P = 0.004$). The mean (± standard deviation) number of adenomas was lower in the aspirin group than the placebo group (0.30 ± 0.87 vs. 0.49 ± 0.99; $P = 0.003$ by the Wilcoxon test). The adjusted relative risk of any recurrent adenoma in the aspirin group, as compared with the placebo group, was 0.65 (95% confidence interval, 0.46–0.91). The time to the detection of a first adenoma was longer in the aspirin group than in the placebo group (hazard ratio for the detection of a new polyp, 0.64; 95% confidence interval, 0.43–0.94; $P = 0.022$).

CONCLUSIONS: Daily use of aspirin is associated with a significant reduction in the incidence of colorectal adenomas in patients with previous colorectal cancer. Our results, together with the strong existing evidence that adenomas are precursors of colorectal cancer, indicate that aspirin use may decrease the risk of colorectal cancer.

Adapted from Sandler RS et al. A randomized trial of aspirin to prevent colorectal adenomas in patients with previous colorectal cancer. N Engl J Med 348:883-890, 2003. Reprinted with permission.

Activity 1

Stating an Abstract's Conclusions and Implications

When writing your abstract, you must include everything your reader will need to know to understand how you arrived at your conclusions. By the time an author has written the rest of the paper and is writing the abstract, the information may seem so familiar that he or she neglects to mention a vital fact that is necessary for the reader to understand the study or its conclusions. Therefore, when writing the abstract, always ask, "Does the information I've included about the background, methods, and results support my conclusion?" If the answer is no, the logic of your abstract will be flawed.

The following structured abstract contains all the information needed to draw a specific conclusion. Read the entire abstract and write a conclusion that is supported by the facts given. Then write a sentence suggesting a possible implication of the study's conclusion.

Background: After the Chernobyl nuclear power plant accident in April 1986, a large increase in the incidence of childhood thyroid cancer was reported in contaminated areas. Most of the radiation exposure to the thyroid was from iodine isotopes, especially ^{131}I. There is compelling evidence that the observed increase in childhood thyroid cancer is related to the fallout from Chernobyl, but questions remain concerning the magnitude of the thyroid cancer risk associated with these radiation exposures and the role of iodine deficiency in modifying this risk. We carried out a population-based case-control study of thyroid cancer in Belarus and the Russian Federation to evaluate the risk of thyroid cancer after exposure to radioactive iodine in childhood and to investigate environmental and host factors that may modify this risk.

Methods: We studied 276 case patients with thyroid cancer through 1998 and 1300 matched control subjects, all aged younger than 15 years at the time of the accident. Individual radiation doses were estimated for each subject based on his or her whereabouts and dietary habits at the time of the accident and in the following days, weeks, and years; subjects' likely stable iodine status at the time of the accident was also evaluated. Data were analyzed by conditional logistic regression using several different models. All statistical tests were two-sided.

Results: A strong dose-response relationship was observed between radiation dose to the thyroid received in childhood and thyroid cancer risk ($P < 0.001$). For a dose of 1 Gy, the estimated odds ratio of thyroid cancer varied from 5.5 (95% confidence interval [CI] = 3.1 to 9.5) to 8.4 (95% CI = 4.1 to 17.3), depending on the risk model. A linear dose-response relationship was observed up to 1.5 to 2 Gy. The risk of radiation-related thyroid cancer was three times higher in iodine-deficient areas (relative risk [RR]= 3.2, 95% CI = 1.9 to 5.5) than elsewhere. Administration of potassium iodide as a dietary supplement reduced the risk of radiation-related thyroid cancer by a factor of 3 (RR = 0.34, 95% CI = 0.1 to 0.9, for consumption of potassium iodide versus no consumption).

Conclusions: [Our results show that ....]
[These findings suggest that ....]

Adapted from Cardis E et al. Risk of thyroid cancer after exposure to ^{131}I in childhood. J Natl Cancer Inst 97:724–732, 2005.

Solution to Activity 1, Stating an Abstract's Conclusions and Implications

The authors accomplished their purpose—they quantified the risk of thyroid cancer and identified environmental and host modifiers of this risk. Note that both the conclusions and the implication that appear below are supported by the major findings reported in the Results paragraph of the abstract.

Conclusions: Children exposed to ^{131}I at doses like those seen after the Chernobyl accident have a significantly increased risk of thyroid cancer, and this risk is dose dependent. Both iodine deficiency and iodine supplementation appear to modify this risk. These results have important public health implications: stable iodine supplementation in iodine-deficient populations may substantially reduce the risk of thyroid cancer in case of exposure to radioactive iodine in childhood.

Adapted from Cardis E et al. Risk of thyroid cancer after exposure to ^{131}I in childhood. J Natl Cancer Inst 97:724–732, 2005.

Abstract Section Worksheet

- Include information that reflects the information in the paper.
- Include information that highlights the study's importance.
- Do not include information that is not in the paper.
- Do not make reference to tables or figures.
- Use wording for hypothesis/purpose statement and conclusion(s) that is similar to or the same as that in the paper.

Background
rationale for study and gap in knowledge (1 or 2 sentences)

hypothesis or purpose statement (1 sentence)

general experimental design (optional)

Methods (and a result for every method)

1

2

3

4

Etc.

Results (and a method for every result)

1

2

3

4

Etc.

Conclusions (and implications)