Sequential results? IRDAM journals? Both of these entities really exist, and both are relevant to how results are reported for some types of studies. How and when they apply become clearer if we start with a refresher on the organization of the scientific paper. An earlier article in this series (1) introduced the IMRAD4 format (Introduction, Methods, Results, and Discussion), a standard set in 1972 by the American National Standards Institute and the most commonly used format today. This format works well for studies in which the experiments are planned in advance or performed in a predefined order. It therefore includes a study design subsection in the Methods section, usually at the beginning. Examples of these types of studies include method development and validation, randomized controlled trials, studies of diagnostic test performance, intervention trials, and observational studies.

In contrast, basic research studies often begin with a hypothesis to be tested, but beyond the initial experiment or starting point, the experiments performed throughout the study are not necessarily planned in advance. In fact, the results of one experiment typically set the direction for subsequent experiments. Because the results, not a preset series of experiments or methods, drive the study, articles written for many basic research journals tend to emphasize the Results section and subordinate the Methods section to the Results. The format used by many high-impact basic research journals, such as Nature, Proceedings of the National Academy of Sciences, Journal of Clinical Investigation, and Journal of Cell Biology, is arranged so that the results section immediately follows the Introduction. The Methods section is placed at the end, or it may even be published as a supplemental data file. This is the IRDAM format (Introduction, Results, Discussion, and Methods) (2).

The IRDAM format requires a substantial change in how the Results section is organized. Because the methods are listed at the end of the paper, or online, the reader is not exposed to details of the experimental protocols and methods before the results are presented. Therefore, the rationale for why these experiments were performed, how they were performed, and how the data were analyzed has to be presented in the Results section to pull the story back together for the reader. This goal is accomplished through the presentation of sequential results. In addition, the last paragraph of the Introduction section may be expanded so that instead of ending with the study question or hypothesis, it goes on to state the experimental approach and the answer to the study question or take-home message of the results.

Sequential Results Format

A sequential Results section generally consists of a series of subsections of 1 to 2 paragraphs. Each of these subsections contains its own subheading and pertains to a separate experiment. The basic format, repeated in each subsection, includes 4 elements: the question, the overview of the experiments, the results, and the answer to the question (3) (Table 1).

The question is usually stated as the purpose or goal of that particular part of the study. Sometimes it is helpful to add some background information that puts the question into the context of the overall study. Given that describing how the results were obtained is essential for the reader to assess their validity, the next element in the sequential results format is an overview of how the experiment was designed, what methods were used and perhaps why they were used, any modifications that were made, and what control experiments were included. Remember that this element consists of an overview of the experiment only; specific details about the experiment belong in another part of the paper, usually the Methods section and figure legends, but sometimes in an online data file. The results or findings of the experiment come next, usually through a descriptive presentation that includes summarized data and reference to tables and figures. The answer is provided in 1 to 2 sentences. Where appropriate, a con-

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1 Scientific research papers should avoid the use of nonstandard abbreviations in titles (exceptions being well-known ones or long expanded forms); however, educational or special feature articles may take liberties to attract the reader’s attention.

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4 Nonstandard abbreviations: IMRAD (format), Introduction, Methods, Results, and Discussion; IRDAM (format), Introduction, Results, Discussion, and Methods.
clusion or a comment about the results can be added as well.

Each of these sequential Results subsections becomes a kind of miniversion of a paper, in which some background is provided about why the experiment was performed or what question was being addressed, how it was tested, the results obtained, and the answer to the question. This format also parallels the format used in the Abstract at the beginning of the paper, but in this case summarizing an individual experiment rather than the overall study.

We illustrate an expanded Introduction section and the first 2 subsections of a sequential Results section in Example 1. In the Introduction paragraph of the example, sentence A states the question of the study, which would be the usual way to end an Introduction in an IMRAD paper. Given that it is an IRDAM paper, the Introduction is expanded by having sentence B state the experimental approach used to address the question and having sentence C answer the question.

In the 2 subsections of sequential results, each of which consists of 1 paragraph, note that each subsection is preceded by a specific, rather than a generic, subheading that states the result. Each experiment gets its own new subheading and paragraph (or paragraphs, if required). If more experiments were done, the sequence would continue accordingly. In the first subsection, sentence A provides background; sentence B states the question or purpose of the experiment and describes the experiment; sentences C, D, and E state the results; and sentence E also gives the answer. In the second subsection, sentence F states the next question, G describes the experiment, H states the results, and the last sentence gives the answer.

Table 1. Elements of a sequential results format.

| Question: | The hypothesis, purpose, or goal | May include background information |
| Experiment: | Overview of design, methods, controls | Full details provided elsewhere in the paper |
| Results: | The findings from the experiment | Can include summarized data |
| | Reference to figure or table | |
| Answer: | What the results show, prove, confirm | Can add conclusion or comment |
| | Other interpretation saved for Discussion |

**Emphasizing Results in a Paragraph That Contains Other Information**

We have just seen in the example that the results wind up buried in the middle of the paragraph. To emphasize results when so much else is happening in the paragraph, you can “signal” to the reader that the sentence contains results by beginning that sentence with the phrase “We found,” “We observed,” or “We detected” (3).

In addition to signaling the results, you can also signal other elements of the sequential results format and thereby keep the story line clear. In the example, the question for each experiment is signaled slightly differently, by the use of “To investigate whether” in sentence B of subsection 1 and by “to determine the extent” in sentence F of subsection 2. The answer is signaled clearly in subsection 2 by “Thus” at the beginning of sentence I. Other options would be to start the answer sentence with “Therefore,” “This result shows,” or “These findings indicate.” In the example, the answer to the question in sentence E illustrates another technique for making the answer clear. The sentence begins with a results statement noting that this result is especially important (“Of more interest”) but ends by stating that the result is “consistent with IL-6γ contributing to vascular inflammation.” The phrase “consistent with” links the result back to the question.

**Final Thoughts**

A well-known idiom asks whether the ends justify the means, but in scientific studies, reviewers and readers expect to know whether the means (the methods) justify the ends (the results). Because the Results section of an IRDAM scientific paper is bracketed by the Introduction and the Discussion, it has a different narrative structure than that of an IMRAD paper. By providing the results together with the rationale for the experiments, how they were performed, and how the data were analyzed, the sequential results format is key to revealing enough of the story for the reader to decide whether the means justify the ends in studies published in journals that follow the IRDAM format.

**Resources and Additional Reading**


Example 1. A Typical Last Paragraph of the Introduction Section and 2 Subsections of the Sequential Results Section for a Hypothetical Study

Introduction (last paragraph of the section) 1

A We sought to answer the question of whether interleukin-6 (IL-6) is a cause or just a marker of vascular inflammation associated with atherosclerotic disease. B Using a herpes simplex virus type 2 (HSV2) infection model to bring about continuous production of IL-6, we investigated the effects of IL-6 production on the development of vascular inflammation and atherosclerotic lesions in mice. C Our results show that in contrast with continuous production of β-selectin or vascular lipoprotein-binding molecule (VLM), 2 other markers of vascular inflammation, IL-6 appears to play a direct role in the formation of atherosclerotic lesions in mice.

Results (first 2 subsections, each consisting of 1 paragraph)

1 Increased plasma IL-6, β-selectin, and VLM after gene injection. A Viral vectors have been successfully used to generate the in vivo production of ferritin and transcobalamin (10, 11). B To investigate whether protein markers of vascular inflammation and atherosclerosis could be generated via a virus-infection protocol, we prepared plasmid HSV2-IL-6, HSV2-β-selectin, and HSV2-VLM by cotransfection of the virus with cDNA encoding IL-6, β-selectin, and VLM, respectively (12). C Four weeks after percutaneous injection with \( 1 \times 10^7 \) infectious units, we detected no IL-6, β-selectin, or VLM in plasma from control mice injected with non-cotransfected HSV2. D Only IL-6 was present in plasma from mice injected with HSV2-IL-6 (Figure 1), only β-selectin was present in mice injected with HSV2-β-selectin (Figure 1B), and only VLM was present in mice injected with HSV2-VLM (Figure 1C). These results show that the HSV2 model could stimulate continuous production of these 3 proteins. E Of more interest was the fact that at 24 weeks, the mice injected with HSV2-IL-6 demonstrated the vascular inflammation markers β-selectin and VLM in plasma as well, a finding consistent with IL-6 contributing to vascular inflammation.

2 IL-6 increases development of atherosclerotic lesions. F We next sought to determine the extent to which overexpression of IL-6, β-selectin, or VLM contributes to the formation of atherosclerotic lesions. G Twenty-four weeks after injection, the mice were killed, and the areas of the atherosclerotic lesions in the aortic roots were assessed by morphologic analysis and immunohistologic staining with eosin or Sudan IV. H We observed that the mean areas of lesions in mice injected with HSV2-IL-6 were 2.4-fold and 2.2-fold larger than the lesions in mice injected with HSV2-β-selectin or HSV2-VLM, respectively (Figure 2), and 2.7-fold larger then the control mice. I Thus, IL-6 appears to contribute to the formation of atherosclerotic lesions.

1 The references and figures mentioned in this example do not correspond to any actual references or figures in the present article.