

Show Your Cards: The Results Section and the Poker Game

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In 5-Card Draw, one of the most popular versions of poker, you start with a specific question: “Can I win with the cards I have decided to play?” The final answer is yes or no. After looking at your initial cards (initial findings) you can be satisfied with what you have (preliminary data) or seek some new cards (new experiments). But in the end you must openly “show your cards” (results). Your cards give you the answer. You cannot hide a card, nor can you add an undealt card to make your hand look better. Playing poker and writing the Results section of a scientific paper have similarities, as I will point out in this article.

Presenting Your Results

In poker, how you present your cards affects how your competitors grasp the importance of the cards. One winning set of cards in poker is the *straight*, defined as 5 consecutively sequenced cards (e.g., 6, 7, 8, 9, 10). You may have this group of cards, but if you present them as 6, 10, 8, 7, 9, your straight is not immediately evident. The worth of cards when presented in a logical manner is clearer and easier to grasp. The same holds true for your Results section. Your important results may be better understood if presented in a certain order.

There are several options for the presentation order of results (Table 1); one may work better than another for the type of study being reported. The most straightforward approach is to use a chronological order with subheadings that parallel the methods and their sequence presented earlier in the paper. This order allows readers to more easily go back and refer to the methods associated with a given result.

A second approach is to group results by topic/study group or experiment/measured parameter. An example of this format is a comparison of the diagnostic and analytical performance of 3 assays for serum prostate-specific antigen. If grouped by assay as the *topic*, the results for diagnostic accuracy, analytical per-

formance, interference testing, and cost analysis for assay 1 would be presented first, followed by a separate presentation of the same results for assay 2 and then assay 3. This order allows the reader to see the results for each assay as a packet of information, which is a logical way to remember information. By comparison, if the results are grouped by *measured parameter*, important similarities or differences in assay performance may be clearer and can be emphasized as important findings.

Grouped by topic:

Assay 1: diagnostic accuracy, performance, interferences, cost.

Assay 2: diagnostic accuracy, performance, interferences, cost.

Assay 3: diagnostic accuracy, performance, interferences, cost.

Grouped by measured parameter:

Diagnostic accuracy: assay 1, assay 2, assay 3.

Performance: assay 1, assay 2, assay 3.

Interferences: assay 1, assay 2, assay 3.

Cost: assay 1, assay 2, assay 3.

In clinical studies that involve multiple groups of individuals or patients receiving different treatments, it is common to order the results from general to specific. The characteristics of the overall study population, such as sex and age distribution, initial and final numbers in each group, and dropouts are first presented. This information is followed by the data and results for each specific group, i.e., starting with the control group or the group receiving the standard treatment, followed by the results for the disease group or the group receiving the experimental treatment. Lastly, if you undertook a study for which the order in which the results are presented is not critical to their being understood, presenting the results from most to least important immediately highlights the results you want to emphasize.

Results should be presented in the past tense. The Results section usually ends up heavier on the passive voice, but some conscious use of the active voice can help the flow and readability of the text (e.g., “we observed that the 2 groups” versus “it was observed that the 2 groups”).

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Table 1. Options for presentation order of results.

- | |
|------------------------------------|
| 1. Chronological order |
| 2. Grouping by topic or experiment |
| 3. General to specific |
| 4. Most to least important |

Data and Results Are Not the Same

One valuable lesson I learned about writing a well-crafted Results section came from Zeiger's book, *Essentials of Writing Biomedical Research Papers*. The same concept—namely, that data and results are not the same—was discussed more recently in an article by Foote in the journal *Chest* (see Resources and Additional Reading). Authors can err by offering the reader results but no data, or data but no results. Data are facts and numbers. Data are usually presented in tables and figures as raw data (individual data points) or summarized data (mean, percent, median and range). Results are statements in the main text that summarize or explain what the data show. As an example, let's use a hypothetical study comparing the effectiveness of radiation treatment, chemotherapy with an existing drug (Blasteride), and a new monoclonal antibody-based therapy (Neuroxomab) for the treatment of neuroblastoma. One of the endpoints in the study is survival rate after diagnosis and initiation of treatment (Figure 1). Four ways to present the information in Figure 1 for the reader might be as follows:

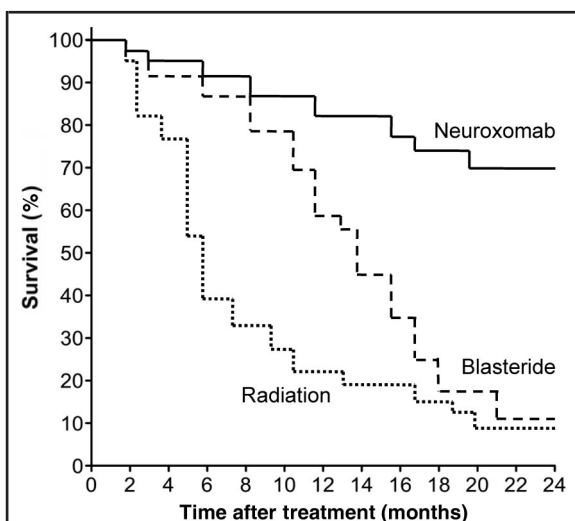


Fig. 1. Two-year survival rates for patients with neuroblastoma treated with Neuroxomab, Blasteride, and radiation.

Figure 1 shows the survival rates following diagnosis and initiation of treatment in the 3 treatment groups. At 6 months the survival rates were 95% for the Neuroxomab group, 91% for the Blasteride group, and 39% for the radiation-treated group. At 12 months the rates were 83%, 69%, and 23%; at 18 months 74%, 17%, and 15%; and at 24 months were 70%, 11%, and 9%.

Figure 1 shows the survival rates following diagnosis and initiation of treatment in the 3 treatment groups. At 6 months the survival rates were significantly higher in the Neuroxomab and Blasteride treatment groups compared with the radiation-treatment group. At 12, 18, and 24 months the survival rates in the Neuroxomab group exceeded those of both the Blasteride and radiation-treatment groups.

Six months after diagnosis and initiation of treatment, the survival rates for the Neuroxomab and Blasteride groups were 2.4 and 2.3 times higher, respectively, than the radiation treatment group (both $P < 0.001$), but survival rates were not found to differ between the Neuroxomab and Blasteride groups ($P = 0.56$) (Figure 1). By 12 months, however, patient survival in the Neuroxomab group was 1.2 times higher than in the Blasteride group ($P = 0.031$), and 4.3 and 6.4 times higher at 18 and 24 months (both $P < 0.001$).

Six months after diagnosis and initiation of treatment, survival rates in the Neuroxomab and Blasteride groups (95% and 91%, respectively) were significantly higher than in the radiation treatment group (39%, $P < 0.001$ for both), but survival rates were not found to differ between the Neuroxomab and Blasteride groups ($P = 0.56$) (Figure 1). By 12 months, however, the patient survival rate in the Neuroxomab group was significantly higher than in the Blasteride group (83% vs 69%, $P = 0.031$), a difference that became even greater at 18 and 24 months (74% vs 17% and 70% vs 11%; both $P < 0.001$).

The first paragraph above provides data but no results. What do the data show? What is the point? Are the treatment groups statistically different at 6 months? The second paragraph contains results but no data. Is it clear from the figure how much higher the survival rates for patients in the Neuroxomab and Blasteride groups were compared with patients in the radiation group and with each other? What is the level of significance of any differences?

Paragraphs 3 and 4 above contain both data and results. They describe the important treatment differences and report when the differences occurred and whether they were statistically significant. Paragraph 3 states the magnitude (e.g., 2.4 times higher) of the most important differences between the treatments, and whether the differences were statistically significant. The reader must look at the figure to see the percent survival data, but this is perfectly fine as long as the

Table 2. Neuroblastoma survival rates over time for Neuroxomab, Blasteride, and radiation-therapy patient groups.

Time, months	Survival, %		
	Neuroxomab	Blasteride	Radiation
6	95 ^{a,b}	91 ^a	39
12	83 ^{a,c}	69 ^a	23
18	74 ^{a,d}	17 ^e	15
24	70 ^{a,d}	11 ^e	9

^a $P < 0.001$ vs radiation group.
^b $P = 0.56$ vs Blasteride.
^c $P = 0.031$ vs Blasteride.
^d $P < 0.001$ vs Blasteride.
^e Not significant vs radiation group.

reader can fairly easily estimate the percentages at 6, 12, 18, and 24 months.

Paragraph 4 includes the actual survival rates (e.g., 95%, 91%, and 39% at 6 months) rather than the relative magnitudes of any differences. The inclusion of these survival-rate data in this paragraph is acceptable because the figure contains a lot of information and you are highlighting selected important differences. However, let's now say that the survival data and P -values had been provided in a table (Table 2). Because Table 2 contains the same information included in paragraph 4, you need not repeat this information in both places:

Six months after diagnosis and initiation of treatment, the Neuroxomab and Blasteride groups showed significantly higher survival rates compared with the radiation-treatment group (Table 2), but survival rates in the Neuroxomab and Blasteride groups were not found to differ. By 12 months, however, patient survival in the Neuroxomab group was significantly higher than in the Blasteride group, a difference that became even greater at 18 and 24 months.

This rule about nonrepetition of data is not absolute, but is a rule that should be broken only in rare circumstances. If a table or figure supplies a large amount of data, it is acceptable to restate a key piece of data in the text, such as the 2 groups in the table with statistically significant differences, if this helps the reader zero-in on an important result without having to plow through a long list of data.

State the Result, the Whole Result, and Nothing but the Result

In the American judicial system witnesses are sworn in by asking if they will tell the truth (the facts), the whole

Table 3. Reporting guidelines for various types of studies.

Consolidated Standards of Reporting Trials (CONSORT; www.consort-statement.org/)
Enhancing the Quality and Transparency of Health Research (EQUATOR; www.equator-network.org/home/)
Metaanalyses of Observational Studies in Epidemiology (MOOSE; JAMA 2000;283:2008–12)
Minimum Information about a Microarray Experiment (MIAME; www.mged.org/Workgroups/MIAME/miame_2.0.html)
Minimum Information for Biological and Biomedical Investigations (MIBBI; mibbi.org/index.php/Main_Page)
Minimum Information for Publication of Quantitative Real-Time PCR Experiments (MIQE; Clin Chem 2009;55:611–22)
Preferred Reporting Items for Systematic Reviews and Metaanalyses (PRISMA; www.prisma-statement.org/)
Standards for the Reporting of Diagnostic Accuracy (STARD; www.stard-statement.org/)
Strengthening the Reporting of Observational Studies in Epidemiology (STROBE; www.strobe-statement.org/)

truth (tell everything), and nothing but the truth (no lies, conjecture, or interpretation). A complete Results section in a scientific paper also satisfies these requirements. Telling the facts is the easy part, because this is the goal of this section: to tell the reader what you found during the study. Requirements 2 and 3 above are areas in which authors can run into problems.

Satisfying the second requirement involves an intentional effort to include all data. There are well-crafted guidelines and checklists available that can help you meet the minimal standards for reporting data and results for many types of studies (Table 3). As an author you should use the checklists and flow diagrams in these guidelines when appropriate for your study. Doing so not only helps make the strengths, weaknesses, and sources of bias clear to the reader, but also helps you remember to include key data that otherwise inadvertently might have been omitted. For example, how many patients were excluded from the study? How many were lost to follow-up? How many dropouts were there? How many patients finished the study? How many individuals had an inconclusive result or diagnosis? These are all data and results and belong in the Results section.

Including all results also means not leaving out a negative result (hiding a card) or a result relevant to the report because it serves some other purpose for you as the author. Anyone who chooses to repeat your work or use your methods will likely encounter the same type of negative results that you did, and the fact that these were not acknowledged in your paper will not serve

you well. Referring to “unpublished results” annoys most editors and peer reviewers unless you can present a good argument for not including them. Trying to stake a claim to a future study by presenting an attention-grabbing preliminary result, but then not showing any corresponding data, can make readers question your motive.

The Results section is just that: results. To satisfy the third requirement above, this section should contain nothing but the results. No methods, no discussion. There is a temptation to remind the reader about the details of the experiment performed or the method used to generate the results, especially if it has been several pages since the Methods section ended. Method, study, and experimental details should not be restated in the Results section. Of course, you can refer to a specific experiment or method when describing the corresponding results; just do not repeat experimental details already described in the Methods section, as exemplified below. Although well intended as a link between a method and a result, the first 2 sentences of the next paragraph are unnecessary:

We compared the death rates for the 262 healthy controls with those of the 203 congestive heart failure patients over a 2-year period. Survival curves were generated with the Masterson mortality index formula. The congestive heart failure group was found to have a significantly higher short-term mortality rate.

However, this example is a good opportunity to illustrate how a transition phrase can serve as a link between a previously described experiment and a result without repeating what was in the Methods section:

When the 2-year survival curves for healthy controls and congestive heart failure patients were compared, the congestive heart failure group was found to have a significantly higher short-term mortality rate.

The only time that experimental details are appropriate for the Results section is when the initial experiments (rightly described in the Methods section) yield data that lead to additional experiments, not part of the original protocol, but which became necessary later on. The description of these experiments may make more sense if included in the Results section with the corresponding results.

When reporting results, authors feel an urge to comment on the results, e.g., how the results compared with prior work, were consistent with what was predicted in another paper, or explained the reason that a marker is increased in a disease. The interpretation or analysis of the results, however, belongs in the Discussion section. In the Results section you can describe what the data show, in the Discussion section you describe what the data mean.

“Significance” Is Misused a Significant Amount of the Time

The purposely incorrect heading here is meant to emphasize the fact that the terms *significant*, *significance*, and *significantly* are used erroneously in many submitted papers. In biomedical publications these terms are intended to identify relationships that have been statistically tested and determined unlikely to have occurred by chance. These terms should also be followed by a mathematical value or limit (e.g., $P = 0.067$ or $P < 0.001$). Unless you have such proof of statistical significance, you should use other terms such as *substantial*, *considerable*, or *noteworthy*. Similarly, authors like to draw unwarranted attention to nonsignificant findings by stating that the data “trended toward” or “tended to show.” If the findings are not clear, don’t try to imply something about them that cannot be supported.

Consistency of Results with Other Sections

Lastly, make sure that the Results section is consistent with all of the other sections in the final version of your paper. Is there a result that does not have a corresponding method or experiment in the Methods section? Conversely, is there a method or experiment for which you have reported no results? Is there a result not covered in the Discussion section, or discussion of a result not contained in the Results section? Are the most important results the same as those highlighted in the Abstract? Do the results relate to the study question, hypothesis, or problem first presented in the Introduction?

Learning Exercise

1. Point out which information is data and which is a result in the following paragraph:

Baseline median IL-6 concentrations were 12, 26, 96, and 144 $\mu\text{g/L}$ for categories 1 to 4, respectively, and were not found related to age or sex. Median β -selectin concentrations increased 30% across the 4 categories. Increased disease severity and mortality were associated with higher IL-6 concentrations, but not β -selectin. Intraindividual variation for group 1 was 14% for IL-6 and 36% for β -selectin.

2. Choose whether the presentation of results in the following sentence is chronological, grouped by topic/study group, grouped by experiment/measured parameter, general to specific, or most to least important:

The mean (SD) admission interleukin concentrations were 13.6 (1.4) $\mu\text{g/L}$, 10.3 (1.1) $\mu\text{g/L}$, and 3.6 (0.5) $\mu\text{g/L}$ in the coronary bypass graft, percutaneous inter-

Table 4. Serum antiproxin concentrations in patients with congestive heart failure.

Stage/classification	Antiproxin, ng/L, median (interquartile range)
I/healthy	99 (36–144)
II/asymptomatic heart failure	216 (147–296) ^a
III/symptomatic heart failure	556 (328–791) ^{b,c}

^a $P = 0.019$ vs healthy patients.
^b $P < 0.001$ vs healthy patients.
^c $P = 0.017$ vs asymptomatic heart failure.

vention, and congestive heart failure patient groups, respectively.

3. Pretend that a journal editor has decided that you must remove Table 4 from your paper and place the information it contains into the main text. How might you write a paragraph that presents the data and results in this table?

Final Thoughts

A Results section that clearly presents your results, makes effective use of both data and results, includes all the important results, and does not wander off into discussion of the results, will result in a better paper and a greater chance of its acceptance for publication. In the end, isn't that the result you are looking for?

Resources and Additional Reading

Foote M. The proof of the pudding: how to report results and write a good discussion. *Chest* 2009; 135:866–8.
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Answers to Learning Exercise

- Baseline median IL-6 concentrations were 12, 26, 96, and 144 $\mu\text{g/L}$ for categories 1 to 4, respectively [DATA], and were not found related to age or sex [RESULT]. Median β -selectin concentrations increased 30% across the 4 categories [RESULT]. Increased disease severity and mortality were associated with higher IL-6 concentrations, but not β -selectin [RESULT]. Intraindividual variation for group 1 was 14% for IL-6 and 36% for β -selectin [DATA].
- The presentation is grouped by experiment/measured parameter, which is the mean admission interleukin concentration. Even though the data are presented from the highest (13.6 $\mu\text{g/L}$) to the lowest (3.6 $\mu\text{g/L}$) value, the higher value is not necessarily the most important finding.
- Median (interquartile range) serum antiproxin concentrations were 99 (36–144), 216 (147–296), and 556 (328–791) ng/L in healthy individuals, asymptomatic heart failure patients, and symptomatic heart failure patients, respectively. The median concentrations in asymptomatic and symptomatic heart failure patients were 2.2-fold higher ($P = 0.019$) and 5.6-fold higher ($P < 0.001$), respectively, than in healthy individuals, and symptomatic patients had significantly higher serum antiproxin concentrations compared with asymptomatic patients ($P = 0.017$).