

Writing a Scientific Research Paper



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The Story Line for a Hypothesis-Testing Paper:

INTRODUCTION: Question asked (= hypothesis)

* **METHODS:** Experiment(s) done to answer the question (to test the hypothesis)

RESULTS: Results found that answer the question

DISCUSSION: Answer to the question (= whether the hypothesis is true)

The Story Line for Review Articles:

INTRODUCTION: Purpose of the review and why needed at this time

METHODS: Scope of the literature search (key terms, inclusive years, etc)

RESULTS and DISCUSSION: Main results gathered and discussion of that information to synthesize the findings and draw conclusions.

Tackling the Introduction...*focusing on research articles*



The Introduction

Has two functions:

Awakens the reader's interest

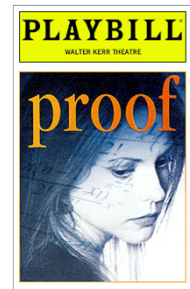
Prepares readers to understand the paper

Like describing the opening scene in a play...

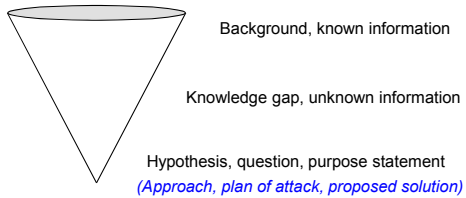
Introduction (Act 1: Setting the scene)

A well-written Introduction sets the scene for the reader.

- Starts by telling the reader what is happening or has happened (the context)
- Ends with a glimpse of what follows in the remainder of the paper (the plot).



Introduction flows from broad to narrow (cone or funnel)



1. Background on general topic

Begin by providing the reader with background information on the topic of the paper.

Describe what is known about a disease, technique, topic, or compound and why it is an important topic.

Make sure that the background information directly relates to your specific study.

Example: If you are reporting a new assay for urine oxycodone... do not devote unnecessary text to the epidemiology, statistics, morbidity, and societal costs of drug abuse in general. *Get to the known information about the need to detect or monitor oxycodone as soon as possible.*

Example: If you are reporting a new marker for pancreatic cancer... do not devote unnecessary text to the epidemiology, therapy, life expectancy, and medical costs of cancer in general. *Get to the known information about pancreatic cancer as soon as possible.*

2. Knowledge gap, unmet need

Narrow the introduction

Focus the reader's attention on:

The importance of continued research

Needed but unknown information

An unsolved problem

A knowledge gap

Limitations of prior studies.

Examples:

Appropriate analytical technique or animal model may be lacking.

The problem has gone unrecognized or a possible solution missed.

Using the analogy of a theatrical production, you should set the scene by putting the necessary background information into the proper context.

3. Hypothesis, question, purpose statement

Now narrow the Introduction again by focusing on the goal of your study (the plot).

From this point on, the text must provide a clear rationale for why you undertook the study. *You test a hypothesis, answer a question, solve a problem, or fulfill a purpose.*

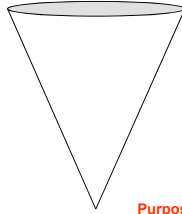
The text should include a statement that makes this clear to the reader...

3. Hypothesis, question, purpose statement

That statement can be one of the following:

- A hypothesis statement:
We hypothesized that...
We tested the hypothesis that...
- A question:
We asked whether...
To answer this question,...
This prompted us to investigate whether...
To resolve this apparent difference...
- A purpose statement:
The purpose of our study was..

Example



General topic or problem: Sepsis is a major cause of morbidity and mortality in individuals who share contaminated needles.

Knowledge gap, unknown information: No preventive treatment has been identified. Can statins help? Animal trials suggest "yes". But studies in humans are limited. Previous human trials were small, observational, with only one population based cohort study.

Purpose statement: Therefore, our aim was to assess the effect of treatment on the rates of sepsis in a prospective cohort study of individuals who had a history of sharing needles.

Sometimes it is helpful to give a brief idea of the method or protocol used in the study. *But save details for the Methods section.*

Examples:

In this study, we asked whether study participants understood the elements of informed consent, as measured by recall of the contents of the informed consent document.

Using a randomized control protocol that included monthly blood drug measurements, we investigated whether ...

Importance of transition phrases/words

Transition phrases and words allow the author to emphasize important points, and also help the reader differentiate the known, the unknown, the question, and the experimental approach.

Transition phrases and words

Examples that can be used to highlight the known, or link the known to the unknown:

- These prior studies show that...
- Supporting the theory that...
- These studies are important because...
- Interestingly,...
- More importantly,...
- Using this information,...
- Yet,...
- Unlike...
- Whereas it has been shown that...
- On the other hand,...
- It is unclear...
- The question remains, however,...
- Although prior studies demonstrated...

Additional transition phrases

Examples of transition phrases that can be used to lead into the question, hypothesis or purpose:

We hypothesized that...

We tested the hypothesis that...

We asked whether...

To answer this question,...

This prompted us to investigate whether...

To resolve this apparent difference...

The purpose of our study was...

This type of presentation tells the reader to expect a clear answer by the end of the article regarding the study goals or hypothesis - i.e., true/false, yes/no, works/doesn't work.

Introductions tend to be too long rather than too short

A long introduction is like a courtroom scene, where an attorney keeps feeding statements to a witness until the frustrated judge asks, "Counselor, is there a question in there somewhere?"



Ways to avoid giving too much information

1. Characterize the audience of the selected journal.

How much information is really need to understand the study question and why it matters?"

2. Go back in time only as far as needed to bring the reader up to speed.

Unless a seminal work, is mention of older work or an older reference necessary?

Introduction: Writing Tips

Create the Introduction by answering questions

Introduction:

- What is the overall topic of my paper?
- What specific aspect did I study?
- What problem needed to be addressed?
- What was my question, hypothesis, goal?

Example:

- Burn injury
- Mechanism of tissue damage after thermal burn
- Whether free radicals contribute to inflammation
- Do antioxidants (e.g., vitamin E) affect inflammation?

Introduction: Writing Tips

Length: As short as possible, consistent with clarity and informativeness.

Typical journal article: 1 double-spaced page (250-300 words) is often sufficient.

For longer introductions: 2 double-spaced pages (500-600 words) is as long as it should be.

Introduction: Writing Tips

Background statement(s): should relate only to the specific subject of the paper.

Gap that your study fills: cite preliminary reports or abstracts or closely related published work, *but avoid using the names of investigators*. Mentioning others by name doesn't help you "hook" the reader.

Introduction: Writing Tips

Biggest problem is lack of focus, attributable to...

Too much background: Literature not cited selectively (briefly) enough. Focus on the findings, not the details or names/dates.

Problems/flaws in previous studies not clearly identified (important if your work is an improvement).

Unclear what previous work was yours.

Weak or missing purpose statement.

Introduction: Writing Tips

Previous Studies: focus on the findings, not names & dates.

Unhelpful: A study by Johnson et al. in 1998, reviewed the medical records of Navy recruits who were unable to complete basic training.

Helpful: Injury rates for recruits undergoing basic training were 12% per year in 1997 for the Australian Army and RAAF, but much higher at 47% for the Navy (1).

Adapted from p. 53 of Peat J, Elliot E, Bauer L, Keena V. *Scientific Writing: Easy When You Know How*. London, UK: BMJ Books; 2002. (Anne Marie Weber-Main, PhD: U Minn)

Introduction: Writing Tips

Previous Studies: Focus on the findings

Too detailed: There have been six previous studies in this area. Henderson, in a study of drug users from France, found....Miller, studying 45 drug users in Milwaukee, showed....Kazan followed 211 drug users and found...

Synthesize: Previous studies on needle sharing have had conflicting results, some suggesting that...whereas others found that...

Introduction: Writing Tips

Previous studies: identify flaws (if your research is an improvement).

Example

Previous research did not account for the possible side effects of prior history of stroke, or have 100% complete follow-up. To address these problems, we...

Introduction: Writing Tips

Previous studies: identify flaws

Example

Most studies did not measure the actual environment experienced by a patient; instead, these studies used proxy measurements of this environment, such as average monthly occupancy rates, or compared weekend with weekday admissions as a surrogate for high and low workloads per provider, respectively.

Introduction: Writing Tips

State the specific human (or animal) population studied:

The purpose of this study was to determine the relative contribution of shared needle use to sepsis and viral infection in patients with a history of intravenous drug use.

Introduction: Writing Tips

Be consistent and continuous in your use of key terms.

Key terms...

name important ideas in the paper...

can be technical: G-protein ♦ mitogenesis

can be non-technical: increase ♦ function

should be repeated exactly from sentence to sentence and paragraph to paragraph, and in the Title, Abstract, and different sections of the paper.

Class participation

Read the Introduction on the next slide and identify key terms that are repeated.

Atherosclerotic disease is a global public health problem. Chronic vascular inflammation has been linked to atherosclerotic disease and sudden death (1-3). Recent studies have demonstrated a strong association between interleukin-6 (IL-6), a recognized systemic marker of vascular inflammation, and atherosclerotic disease (4-6). Additionally, prospective studies have presented data regarding the prognostic value of IL-6 in predicting the severity of underlying atherosclerotic disease and risk of mortality (7,8).

While these association and prospective studies indicate that IL-6 is a predictor of atherosclerotic disease and risk of mortality, they provide little information about the underlying pathophysiology of vascular inflammation and the contributory role, if any, of IL-6.

We therefore investigated in an animal model whether IL-6 is a cause or just a marker of vascular inflammation associated with atherosclerotic disease.

Using a herpes simplex virus type 2 infection protocol to stimulate continuous IL-6 production in mice, we investigated the effects of IL-6 on the development of atherosclerotic lesions, life span, and potential mechanisms of IL-6 induced vascular inflammation.

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Class participation

Review of Sample Introductions

- 1) "Bipolar Disorder" by Aliza Norwood (review article)
- 2) "MZ Hepatitis B" by Leslie Sheu (research article)

The Results Section



Question:

Why not just provide figures and tables with clear titles and informative legends?

Answer:

Data do not speak for themselves.

You must communicate your understanding and interpretation of your data to the reader.

The Results Section

States the results of the experiments or studies.

Only reports results pertinent to the question raised in the Introduction.

Directs the reader to figures or tables that present supporting data.

The Results Section

Presenting your results is like playing a card game.



Presenting Your Results

Example: One winning set of cards is the *straight*, defined as 5 consecutively sequenced cards (e.g., 1, 2, 3, 4, 5).



Presenting Your Results

But you would not state that you have the 1, 2, 3, 4, and 5 of clubs. The cards are your data. Your result is a straight. Your result is your hand beats another hand.



Data and results are not the same!

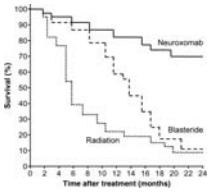
Data are facts, numbers, observations...

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 text that interpret or explain what the data show.

Authors err most often by offering the reader data but no results.





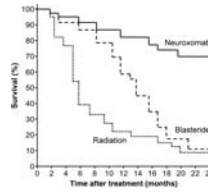
"Six months after diagnosis and initiation of treatment, the survival rates were 95% for the Neuroxomab group, 91% for the Blasteride group, and 39% for the radiation-treated group (Fig. 1). At 12 months the rates were 83%, 69%, and 23%; at 18 months 74%, 17%, and 15%; and at 24 months 70%, 11%, and 9%."

This paragraph provides [data but no results](#):

What do the data show?

What is the point?

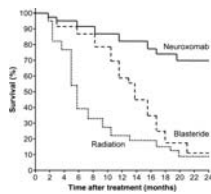
Are the treatment groups different at 6 months?



Six months after diagnosis and initiation of treatment, the survival rates were higher in the Neuroxomab and Blasteride treatment groups than in the radiation-treatment group (Fig. 1). At 12, 18, and 24 months the survival rates in the Neuroxomab group exceeded those of both the Blasteride and radiation-treatment groups."

This paragraph contains [minimal explanation of what the data show](#):

How much higher were the survival rates for the Neuroxomab and Blasteride groups than the radiation group or each other?



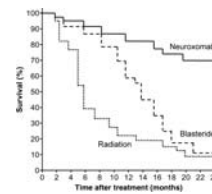
"Six months after diagnosis and initiation of treatment, the survival rates for the Neuroxomab and Blasteride groups were 2.4 and 2.3 times higher, respectively, than the radiation treatment group (both $P < 0.001$), but survival rates did not differ between the Neuroxomab and Blasteride groups ($P = 0.56$) (Fig. 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 $P < 0.001$)."

This paragraph [explains what the data show](#):

The magnitude (e.g., 2.4 times higher) of the most important differences

When the differences occurred

Whether they were statistically significant



"Six months after diagnosis and initiation of treatment, survival rates in the Neuroxomab and Blasteride groups (95% and 91%, respectively) were 2.4 and 2.3 times higher than the survival rate for the radiation treatment group (both $P < 0.001$), but survival rates did not differ between the Neuroxomab and Blasteride groups ($P = 0.56$) (Fig. 1). By 12 months, however, the patient survival rate in the Neuroxomab group was 1.2 times 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 $P < 0.001$)."

This paragraph [explains what the data show and provides some important data from the figure](#):

Includes the actual survival rates (e.g., 95%, 91%, and 39% at 6 months) in addition the magnitude of any differences.

Table 1. Patient survival rates after 3 different treatment regimens.

| Time, months | Survival, % | | |
|--------------|-------------------|-----------------|-----------|
| | Neuroxomab | Blasteride | Radiation |
| 6 | 95 ^{1,2} | 91 ¹ | 39 |
| 12 | 83 ^{1,3} | 69 ¹ | 23 |
| 18 | 74 ^{1,4} | 17 | 15 |
| 24 | 70 ^{1,4} | 11 | 9 |

¹ $P < 0.001$ vs radiation group. ² $P = 0.56$ vs Blasteride. ³ $P = 0.031$ vs Blasteride. ⁴ $P < 0.001$ vs Blasteride.

The main text describes the results, but does not duplicate the data:

"Six months after diagnosis and initiation of treatment, the survival rates for the Neuroxomab and Blasteride treatment groups were 2.4 and 2.3 times higher than for the radiation treatment group, but survival rates did not differ between the Neuroxomab and Blasteride groups ($P = 0.56$) (Table 1). By 12 months, however, patient survival in the Neuroxomab group was 1.2 times higher than in the Blasteride group, a difference that became even greater at 18 and 24 months."

Data in tables should not be repeated in the main text.

One exception:

If a table supplies a *very 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.

Only do this if it helps the reader zero-in on an important result without having to plow through a long list of data.

The Results Section

Options for presentation order of results:

1. **Chronological order** with subheadings that parallel the methods and their sequence presented earlier in the paper.

Allows readers to more easily go back and refer to the methods associated with a given result.

Example:

Order of Methods

Extraction protocols
Derivatization reagents
Chromatographic methods

Order of Results

Extraction protocols
Derivatization reagents
Chromatographic methods

The Results Section

Options for presentation order of results:

2. **Most to least important**

Put results that answer the question *at the beginning of the first paragraph of the Results section.*

Example:

There was a direct correlation between blood mercury concentrations and neuronal fiber unwinding (Fig.1).

The Results Section

Options for presentation order of results:

3. **Grouping by topic or experiment**

Example: Comparison of 3 techniques for postmortem toxicology

Grouped by topic (technique):

- Capillary electrophoresis: detection rate, interferences, cost.
- Liquid chromatography: detection rate, interferences, cost.
- Gas chromatography: detection rate, interferences, cost.

Reader can see the results for each technique as a packet of information – a logical way to remember information.

The Results Section

No discussion!

There is a temptation to comment on the results.

The analysis of the results belongs in the Discussion section.

In the Results section you describe what the data show; in the Discussion section you describe what the data mean.

Class participation

Review & critique the Results section of the sample paper from one of your colleagues:

Does it report only results that are related to the study question at the end of the Introduction?

Does it emphasize results rather than data?

How are paragraphs organized?

The Discussion Section

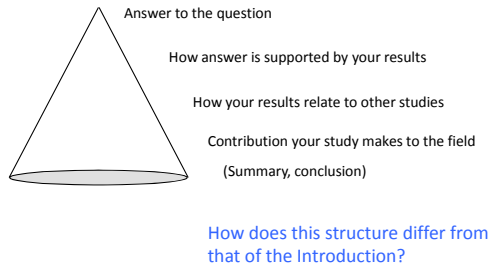
Your Closing Argument

Answers question or hypothesis posed in Introduction.

Relates findings/conclusion to existing knowledge.

Supports your point and your conclusions.

The Discussion flows from narrow to broad
(inverted cone, funnel)



Get started by asking these questions:

What exactly did the study show?

[What might that mean?](#)

How else could the results be interpreted?

[Have other studies had similar results, or is there disagreement in the field?](#)

What are the study's strengths and weaknesses?

[What, exactly, should happen next?](#)

The Discussion is a “story” that consists of the following:

Beginning:

The answer to the study question
(and the key evidence that supports the answer)

Middle:

Explaining/defending the answer
Explaining conflicting results
Secondary findings
Limitations

End:

Conclusion and implications

The Discussion picks up where the Introduction leaves off.

End of the Introduction:

We therefore investigated whether intravenous 4-methylpyrazole (fomiprazole) would attenuate the metabolic acidosis and prevent the renal tubular damage associated with ethylene glycol intoxication.

Beginning of the Discussion:

In this study, we investigated whether intravenous 4-methylpyrazole (fomiprazole) would attenuate the metabolic acidosis and prevent the renal tubular damage associated with ethylene glycol intoxication. *Our results show that ...*

The first paragraph of the Discussion should be very specific and focused.

Get right to the point, which is to answer the question(s) presented in the Introduction.

“... the answer to the question is the culmination of the paper. It deserves the most prominent position in the Discussion—the beginning.”

Zeiger M. Essentials of Writing Biomedical Research Papers. New York: McGraw-Hill; 2000.

Answer to the question

[In this study, we investigated whether](#) intravenous 4-methylpyrazole (fomiprazole) would attenuate the metabolic acidosis and prevent the renal tubular damage associated with ethylene glycol intoxication. [Our results show that](#) 4-methylpyrazole, when given 3 hours after ethylene glycol ingestion, can reduce the degree of metabolic acidosis by more than 85% and renal tubular damage by 90% compared with dialysis alone.

Signal the Answer

This study indicates that

The results of this study show that

In this study, we have shown that

In this study, we provide evidence that

Link Results to the Answer They Support

In our experiments,

In our patients,

The evidence is that

(Answer) has been demonstrated in two ways

Do NOT begin...

With a second introduction

With a summary of the results

With secondary information

The middle of the Discussion can cover many points.

- ✓ Support, explanation and defense of the answer
- ✓ Unexpected findings... Conflicting findings... Secondary findings
- ✓ Sub-group findings (effect modifiers of single most important finding: men vs. women; young vs. old)
- ✓ Findings that contradict other studies, conventional wisdom.
- ✓ Limitations (of methods, of study design), and assumptions—as needed.

Explain or defend the answer.

Support for the answer usually comes at the beginning of the Discussion, in the first paragraph, with the answer itself.

In the middle of the Discussion, you may also need to *explain or defend* the answer:

Why is it reasonable?

How does it fit in with previous studies on the topic?

Explain the answer.

Beginning of Discussion: Consistent with our hypothesis, we found mental illness to be an independent risk factor for unintentional injury and injury recidivism. The mentally ill were admitted for unintentional injury twice as often as those who were not mentally ill. Surprisingly, mental illness had significantly higher odds of unintentional injury recidivism than either substance abuse or homelessness.

Middle of Discussion: The explanation for increased risk of unintentional injury in the mentally ill may be based on changes in perception and awareness. These changes are hallmarks of many mental illnesses. For instance,

Show how the answer is supported by results.

Our first finding that 4-methylpyrazole decreases renal damage is supported by our measurements of both urinary oxalate excretion and renal tubular oxalate concentrations. Twenty-four hours after infusion of 4-methylpyrazole, urinary oxalate excretion was reduced by 88% compared with dialysis treatment, and renal tubular oxalate concentrations were reduced by 78% compared with dialysis. Our finding that 4-methylpyrazole decreases renal damage is also supported by urine protein excretion patterns, which showed no statistically significant difference from healthy controls.

Our second finding that 4-methylpyrazole decreases the degree of metabolic acidosis is supported by our in-line blood pH measurements, which showed changes of less than 0.2 pH units during therapeutic intervention.

Show how your results relate to those from other studies.

Evidence of a competitive effect of 4-methylpyrazole on ethylene glycol metabolism by alcohol dehydrogenase comes from a previous study (3). That study showed that in healthy volunteers, oral doses of 4-methylpyrazole (10 to 20 mg/kg) significantly reduced the rate of elimination of moderate doses of ethanol, which is also metabolized through the action of alcohol dehydrogenase. Two studies (4,5) have demonstrated that 4-methylpyrazole plasma concentrations of approximately 10 $\mu\text{mol/L}$ (0.82 mg/L) in monkeys are sufficient to inhibit methanol metabolism to formate, which is also mediated by alcohol dehydrogenase.

Show the contribution your study makes to the field.

Our demonstration that 4-methylpyrazole blocks ethylene glycol metabolism mediated by alcohol dehydrogenase supports the addition of this competitive inhibitor to the existing repertoire of agents that can add to the effectiveness of dialysis for the treatment of solvent ingestion. The fact that none of the patients who received 4-methylpyrazole showed any allergic side effects supports the safety of this compound in emergency situations.

Discuss secondary findings.

First Paragraph: In this study, we showed for the first time that the *Cu14A* gene is amplified in human mesothelioma cell lines. Consistent with gene amplification, overexpression of Cu14A protein was observed in mesothelioma cell lines and MPM tissues. Further knockdown of Cu14A by shRNA in mesothelioma also inhibited mesothelioma cell growth. Thus, our results indicate that amplification of the *Cu14A* gene may be an important oncogenic event in mesothelioma development.

Second Paragraph: We also observed that down-regulation of Cu14A with shRNA causes cell cycle arrest and growth inhibition through up-regulation of p21 and p27 proteins in a p53-independent manner in mesothelioma cells. Several lines of evidence support this hypothesis. First,

Discuss sub-group findings.

The effects we observed—reduced tumor proliferation, decreased tumor size, and increased apoptotic activity after only 3-6 weeks of fluvastatin treatment—were only evident in subjects with high grade tumors, which suggests the significant differences in response were primarily due to tumor grade, rather than estrogen-receptor (ER) status.

Although the worst outcomes were predominantly in subjects with ER-negative tumors, some were in subjects with high grade ER-positive tumors, further evidence indicating that grade may be more important than ER status in determining tumor response to fluvastatin.

Don't forget unexpected findings, and try to explain them.

A surprising finding was that in mice treated with isoproterenol, oxygen extraction ratios during severe hypoxia were low. The ratios we found were less than 40%, whereas ratios in untreated mice range from 80-90% (2). We suggest two possible explanations of why extraction of oxygen from skeletal muscle was not further increased to minimize the oxygen deficit in the mice treated with isoproterenol. First, blood flow may have been directed... Second, some metabolic autoregulatory stimulus may have... If these explanations are correct, they imply that the oxygen deficit is linked not only to oxygen delivery but also to some tissue signal originating at the cellular level.

Discuss conflicting findings.

The main finding of our study is that β -adrenergic blockade does not impair performance of maximal or submaximal exercise at high altitude. As expected, treatment with the β -blocker propranolol significantly decreased heart rate at high altitude. However, contrary to our hypothesis, subjects treated with propranolol could maintain levels of oxygen uptake during maximal and submaximal exercise as great as those in subjects treated with placebo. This finding cannot be attributed to increased arterial oxygen saturation or hemoglobin concentration... Rather, it appears that oxygen uptake was maintained by increasing stroke volume.

Discuss findings that contradict those from other studies.

Though our results may seem to differ from those of Haley et al. (21), we used a different method of ascertaining compliance with therapy than they did.

Apparent discrepancies between our human growth hormone values and those of earlier studies may be due to differences in study design. In our study, all subject worked at the same relative intensity, etc...

Use Your Work to Support Previous Studies.

The fact that our study was prospective lends support to the evidence of a causal role of sleep-disordered breathing in hypertension. We found that the presence of sleep-disordered breathing was predictive of hypertension four years later.

Use Others' Work to Support Your Study.

Previous studies of the hemodynamic effects of intravenous and oral sildenafil in normal men and men with stable ischemic heart disease have demonstrated a small but consistent decrease in systemic and pulmonary blood pressure after administration of the drug. (refs) The results of our study confirm these findings in men with anatomically severe coronary disease. In addition, we investigated the effects of sildenafil on coronary hemodynamics.

Find the right word(s) to explain the relationship between your work and previous work...

This/Our study/method/result/approach...

is analogous to
is comparable to
is compatible with
is consistent with
contrasts with
is in line with
is significantly different from
is the first of its kind
is (very) similar to

Find the right word(s) to explain the relationship between your work and previous work...

This/Our study...

broadens / challenges / confirms / contradicts / corresponds to / corroborates / differs from / extends / expands / goes against / lends support to / modifies / provides insight into / provides support for / refutes / tends to refute / verifies

Find the right word(s) to explain the relationship between your work and previous work...

Our results are in general agreement with those from previous morphometric and DN incorporation studies in the rat [2,6].

Our current findings expand prior work [5] in showing...

Unlike McGowan, we did not identify 9-*cis* RA in the mouse lung.

Be fair and balanced.

If others' results help support your answer, mention them and cite the appropriate references.

Give appropriate credit to yourself as well, but avoid claiming priority (in most cases).

Of the 4 published procedures for nucleic acid insertion, we chose the one described by Wallenburg and Hughes because their procedure yields the highest percentage of cDNA-transfected viruses. Other researchers have successfully used the same procedure to generate viral vectors for the in vivo production of ferritin and transcobalamin, 2 smaller proteins with molecular weights in the same range as our 3 proteins. We were able to improve the yield of transfected viruses 2-fold by adding 0.01% glycerol to the trypsin-EDTA solution.

Explain limitations of your study.

We recognize limitations of our study...

Our study has some limitations

One limitation of our study is ...

No study is without potential bias

No study is perfectly executed

No study is definitive

Head criticism off at the pass

Example: "A limitation to interpreting long-term success was that 30% of patients who had ingested ethylene glycol and received 4-methylpyrazole did not complete the 6-month follow-up."

Try to present limitation with "redemption".

One assumption we made for the measurement of the pulmonary capillary filtration coefficient was that isolating the lungs did not injure pulmonary vessels. This is a reasonable assumption because we minimized lung ischemia by removing the lungs rapidly (within 5 min). In addition, the baseline K_f values in our study are low and agree with those in other reports (2).

Continuity is Essential

Because the middle can be several paragraphs, organization and continuity are important to keep the story flowing well:

Organize the topics either according to the science or from most to least important.

Use topic sentences at the beginning of each paragraph to tell a story!

Each topic sentence stating the message or the topic of the paragraph; details in logically organized supporting sentences.

Try to link each topic sentence linked to the previous paragraph by
a repeated key term
a transition word
both + the other techniques of continuity as needed

For continuity, use topic sentences at the beginning of each paragraph to tell a story.

Series of topic sentences for 1 study (key terms repeated too):

- 1) In this long-term, multicenter, randomized trial involving patients with abdominal aortic aneurysm, there was no significant difference in the primary outcome of long-term all-cause mortality between the endovascular-repair group and the open-repair group.
- 2) Aneurysm rupture after repair was uncommon but occurred only in the endovascular-repair group, resulting in a significant between-group difference.
- 1) Much of the early enthusiasm for endovascular repair focused on the expected advantage among old or infirm patients who were not good candidates for open repair.

Come to a definite end:

1. Restate the answer to the question.
2. Signal the end by using a phrase such as "In conclusion", or "In summary", so readers will know this is the answer.
3. Then indicate the importance of the work by briefly stating applications, recommendations, implications, or speculations.

Sources (many are also good resources for you to have)

Annesley TM. Deputy Editor, *Clinical Chemistry* and Professor, University of Michigan-- see his series covering all aspects of preparing and submitting a paper for publication at http://www.aacc.org/publications/clin_chem/ccgsw/Pages/default.aspx

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