

How to Write a Scientific Manuscript

Marianne Mallia, ELS

Manager and Senior Medical Writer
Scientific Publications, Texas Heart Institute
Houston, Texas, USA

Cardiology Rounds

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“ . . . the preparation of a scientific paper has less to do with literary skill than with *organization*. A scientific paper is not literature.”

How to Write and Publish a Scientific Paper

– Robert A. Day

GETTING YOUR PAPER ACCEPTED

- The first, and undoubtedly most important, part of the manuscript begins with planning the project. However, poor presentation can ruin a great study.
- [Among journal editors], there was a consensus that presentation could indeed make a difference in whether a paper is published or rejected.
- Clearly, a well-planned and executed project will address most manuscript pitfalls. However, the preparation of the manuscript does matter, and it can make the difference between acceptance or rejection.

Anthony N. DeMaria, MD, MACC

Editor-in-Chief, *JACC*

EXPANDED IMRAD MODEL

- Title
- Authors
- Abstract
- Key words
- **Introduction**
- **Methods**
- **Results**
- **Discussion**
- References
- Acknowledgments

CHOOSING A TARGET JOURNAL

Consider

- Appropriateness for your message
- Type and length of articles published
- Impact factor (Thomson Scientific, Journal Citation Reports: <http://scientific.thomson.com/>):
J. Thorac Cardiovasc Surg (3.73), NEJM (44.06),
Circulation (12.563), Ann Thorac Surg (2.244),
Eur Heart J (6.247), Eur J Cardiothorac
Surg (2.106)
- Likelihood of publication
- Journal circulation

THE TITLE

A good title should

- Accurately, completely, and specifically identify the main topic
- Be unambiguous
- Be concise (100 characters)
- Begin with an important word to attract intended readers
- Include independent and dependent variables and species, if not human
- Be a label suitable for indexing

KEY WORDS

- Used to cross-index the article
- Can increase the number of times the paper is cited
- Use terms from the Medical Subject Headings (MeSH) list of Index Medicus
- Found online: <http://www.nlm.nih.gov/mesh/>

THE TITLE

- Avoid
 - Too scholarly or too “cute” titles
 - Subtitles, whenever possible
 - Acronyms
 - Abbreviations
 - Noun clusters
 - Complement Fixation Laboratory Technique for Adult Rhesus Monkey Antigen Isolation
- Don't use jargon
- Keep word order simple

EFFECTIVE TITLES

- A Randomized Comparison of Radial-Artery and Saphenous-Vein Coronary Bypass Grafts
- Improved Survival After Living-Donor Lobar Lung Transplantation
- Creatine Supplementation Improves Muscle Strength in a Mouse Model of Congestive Heart Failure
- Abnormal Coronary Vasoconstriction as a Predictor of Restenosis After Successful Coronary Angioplasty in Patients With Unstable Angina Pectoris

AUTHORSHIP

Criteria for authorship*

- Participate sufficiently to take responsibility for the content, i.e., be able to defend the content and conclusions
- Make substantial contributions to each of the following areas:
 - Conception and design **or** analysis and interpretation of data
 - Drafting the manuscript **or** revising it critically for important intellectual content
 - Approving the version of the manuscript to be published

*Uniform Requirements for Manuscripts Submitted to Biomedical journals. International Committee of Medical Journal Editors. <http://www.icmje.org/>

AUTHORSHIP

- Determine listings for authors, contributors, and acknowledgments early in the process
- Disclose conflicts of interest that may bias work
- Disclose roles for author and sponsor in company-sponsored studies
- Remember, in references, often only the first 3 or 6 authors are named

THE ABSTRACT

A good abstract should

- State the principal objectives and scope of the investigation
- Describe the methods employed
- Summarize the results
- State the principal conclusions

INTRODUCTION

What question (problem) was studied?

The answer is in the Introduction.

INTRODUCTION

- Catches and keeps the reader's interest
- Uses a “funnel” type of organization
- Include known, unknown, and the question
 - The nature and scope of the problem
 - The gap or general problem
 - Previous findings. Pertinent literature
 - General method statement, ie, retrospective study
 - The hypothesis/research question–signal

INTRODUCTION

- Keep it brief (1–2 pages)
- Use the present tense for what is currently true
- Use the past tense for previous findings
- Use past tense to state the question
- Avoid using names of other investigators
- Repeat key terms from the title
- Make the gap obvious
- Common errors: too much background, no gap, no question

BACKGROUND: NATURE AND SCOPE OF PROBLEM (KNOWN)

“Restenosis after an initially successful percutaneous transluminal coronary angioplasty remains an important unsolved problem with this promising revascularization technique. Retrospective studies have found that several clinical, angiographic, and procedural variables are important predictors of restenosis.¹⁻¹²”

From NEJM 325:1053-7, 1991

THE GAP

“There is considerable variation among the retrospective studies, however, and the results are often difficult to interpret. Prospective trials are clearly needed to confirm the results made in retrospective studies and to assess whether the risk of restenosis can be predicted accurately in specific patients.”

From NEJM 325:1053-7, 1991

PREVIOUS FINDINGS

“Several studies have reported high rates of restenosis among patients with coronary vasospasm, such as Prinzmetal’s angina,¹³⁻¹⁶ as well as among those with coronary lesions susceptible to abnormal vasoconstriction during provocative testing.¹⁷”

From NEJM 325:1053-7, 1991

SIGNALING THE QUESTION

- To determine whether . . .
- The purpose of this study was . . .
- Therefore, we tested the hypothesis . . .
- This report describes experiments designed to determine whether . . .
- Therefore, our first objective in these studies was to determine whether . . .
- In this study, we sought to extend our observations and to specifically test . . .

THE QUESTION

“Therefore, we designed a prospective trial to test whether abnormal coronary vasoconstriction, detected by hyperventilation testing before angioplasty, increases the likelihood of restenosis. A test that could accurately identify patients at high risk for restenosis might influence management.”

From NEJM 325:1053-7, 1991

GENERAL AREA

Restenosis after an initially successful percutaneous transluminal coronary angioplasty remains an important unsolved problem with this promising revascularization technique. Retrospective studies have found that several clinical, angiographic, and procedural variables are important predictors of restenosis.

GAP OR GENERAL PROBLEM

There is considerable variation among the studies, however, and the results are often difficult to interpret. Prospective trials are clearly needed to confirm the observations made in retrospective studies and to assess whether the risk of restenosis can be predicted.

PREVIOUS FINDINGS

Several studies have reported high rates of restenosis among patients with coronary vasospasm, such as Prinzmetal's angina, as well as among those with coronary lesions susceptible to abnormal vasoconstriction during provocative testing.

HYPOTHESIS OR RESEARCH QUESTION

We designed a prospective trial to test whether abnormal coronary vasoconstriction, detected by hyperventilation testing before angioplasty, increases the likelihood of restenosis. A test that could accurately identify patients at high risk for restenosis might influence management.

MATERIALS AND METHODS

How was the problem studied?

The answer is in the Methods.

MATERIALS AND METHODS

- Describe what was done to answer the research question
- Give full details of the methods
- Include a clear statement of study design:
“The EXCITE study was a double-blind, randomized, parallel design ... designed to compare the efficacy and safety of ...”
- Include a sentence about IRB approval, informed consent, or compliance with animal welfare regulations:
“The protocol was approved by the institutional review board, and all patients gave informed consent ...”

MATERIALS AND METHODS

- State the protocol/procedures. Repeat the question:

“We tested the efficacy of Drug X administered orally in a dose of 20 or 30 mg, given 3 times daily for up to 6 months.”

“There were 2 primary endpoints. The first was event-free survival at 182 days, with an event defined as...”
- Write in a logical order (usually chronological)
- Describe analytical methods

MATERIALS AND METHODS

- Use subheadings
- Do not include results in Methods
- Write in past tense
- Use active voice whenever possible
- Place details in parentheses
 - Systolic and diastolic pressure both decreased 10% (160/100 to 146/90).
- Include appropriate figures and tables
- Common errors: statistics

Table 1. Major Eligibility Criteria.

Inclusion criteria

General criteria

Age ≥ 18 yr

Unilateral or bilateral atherosclerotic or restenotic lesions in native carotid arteries

Symptoms plus stenosis of more than 50 percent of the luminal diameter

No symptoms plus stenosis of more than 80 percent of the luminal diameter

Criteria for high risk (at least one factor required)

Clinically significant cardiac disease (congestive heart failure, abnormal stress test, or need for open-heart surgery)

Severe pulmonary disease

Contralateral carotid occlusion

Contralateral laryngeal-nerve palsy

Previous radical neck surgery or radiation therapy to the neck

Recurrent stenosis after endarterectomy

Age > 80 yr

Exclusion criteria

Ischemic stroke within previous 48 hr

Presence of intraluminal thrombus

Total occlusion of target vessel

Vascular disease precluding use of catheter-based techniques

Intracranial aneurysm > 9 mm in diameter

Need for more than two stents

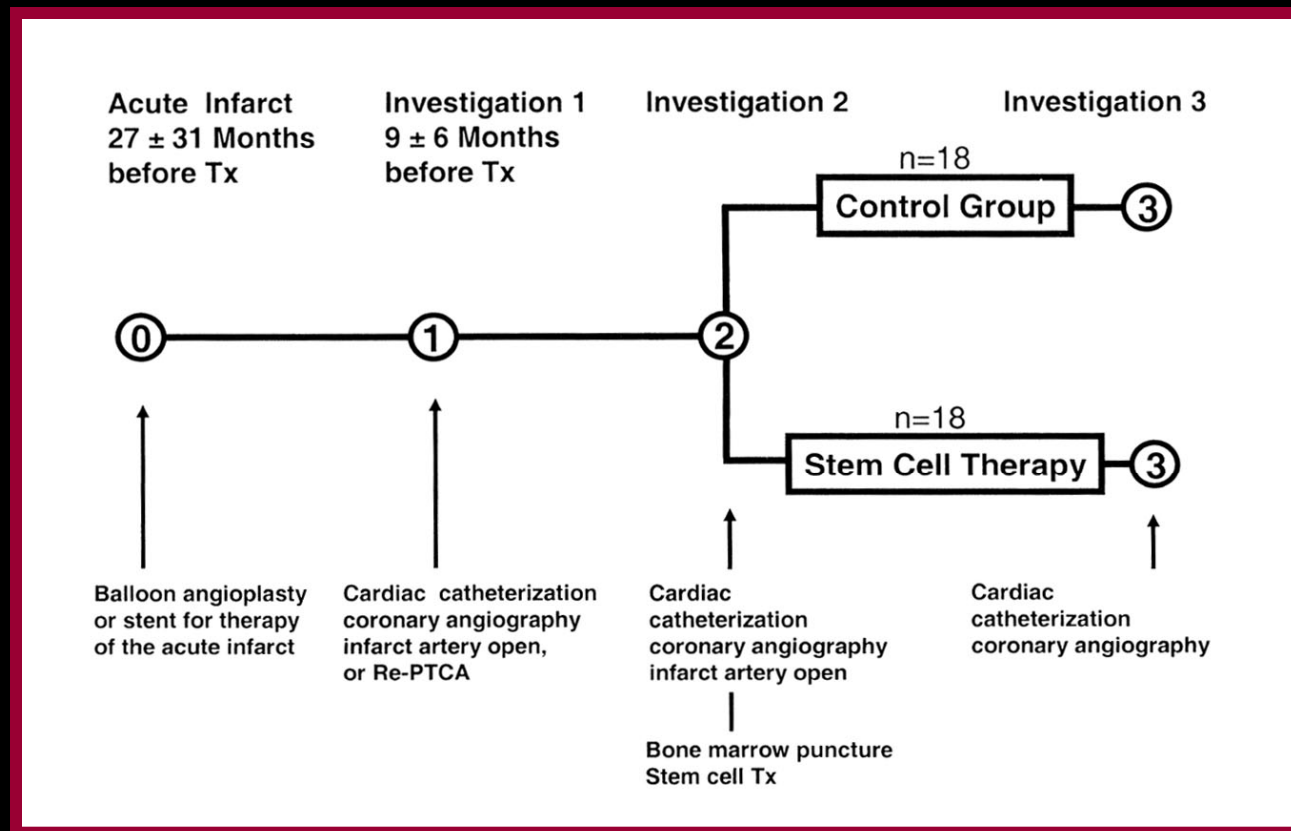
History of bleeding disorder

Percutaneous or surgical intervention planned within next 30 days

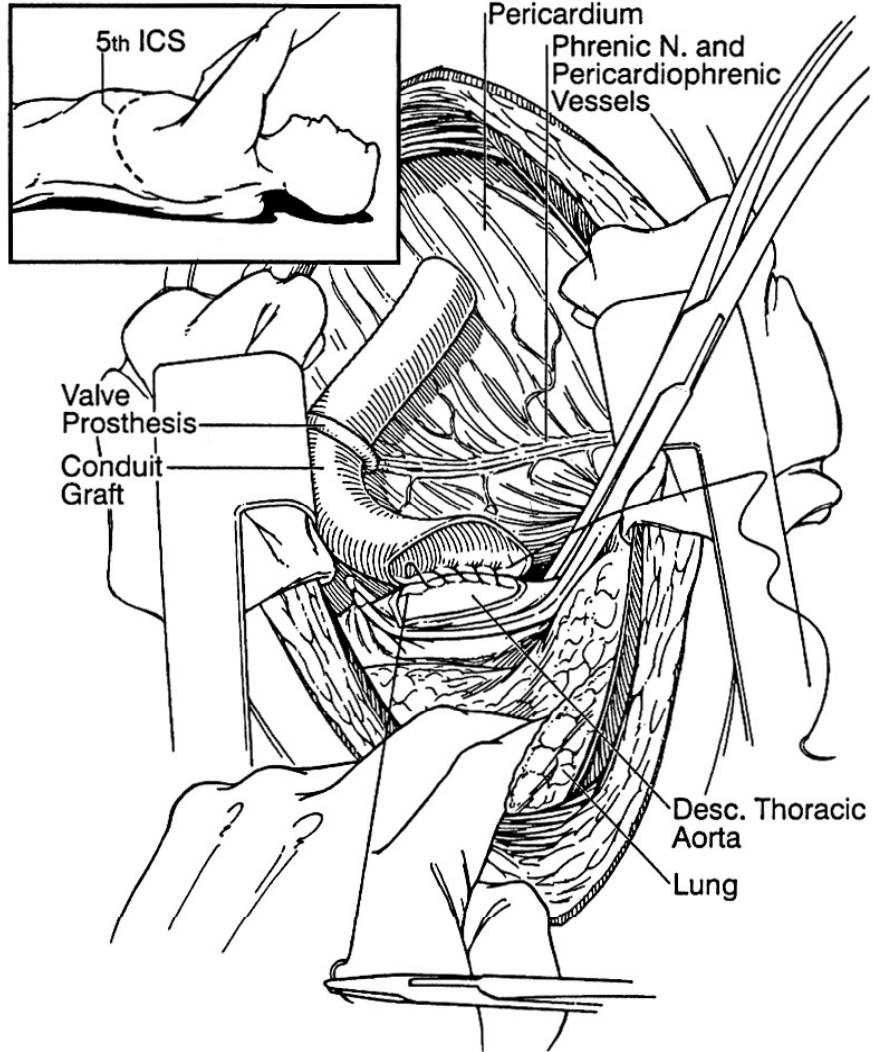
Life expectancy < 1 yr

Ostial lesion of common carotid artery or brachiocephalic artery

STUDY PROTOCOL



A



A step-by-step procedure is best shown in an illustration.

MATERIALS AND METHODS

- Briefly address questions you can anticipate from the reader, eg, justify/clarify the design of your study:

“Emergency surgery was defined as any bypass-graft surgery required on the same day as angioplasty”

MATERIALS AND METHODS

- Treat limitations of this study in a matter-of-fact way:

"These studies were performed as part of a routine clinical assessment, so that no attempt was made to ensure either fasting of the patient or performance of the test at a particular time of day."

RESULTS

What were the findings?

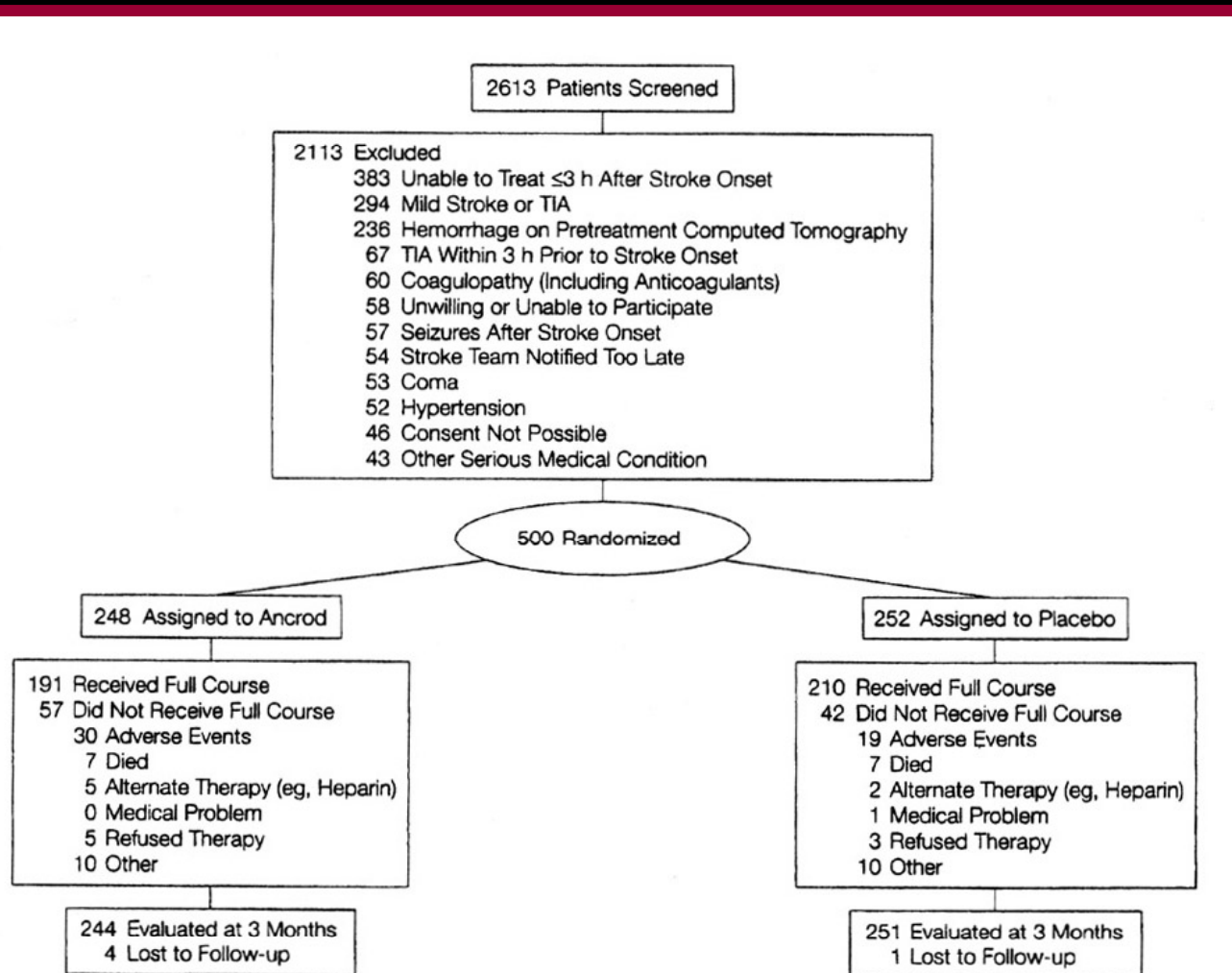
The answer is in the Results.

RESULTS

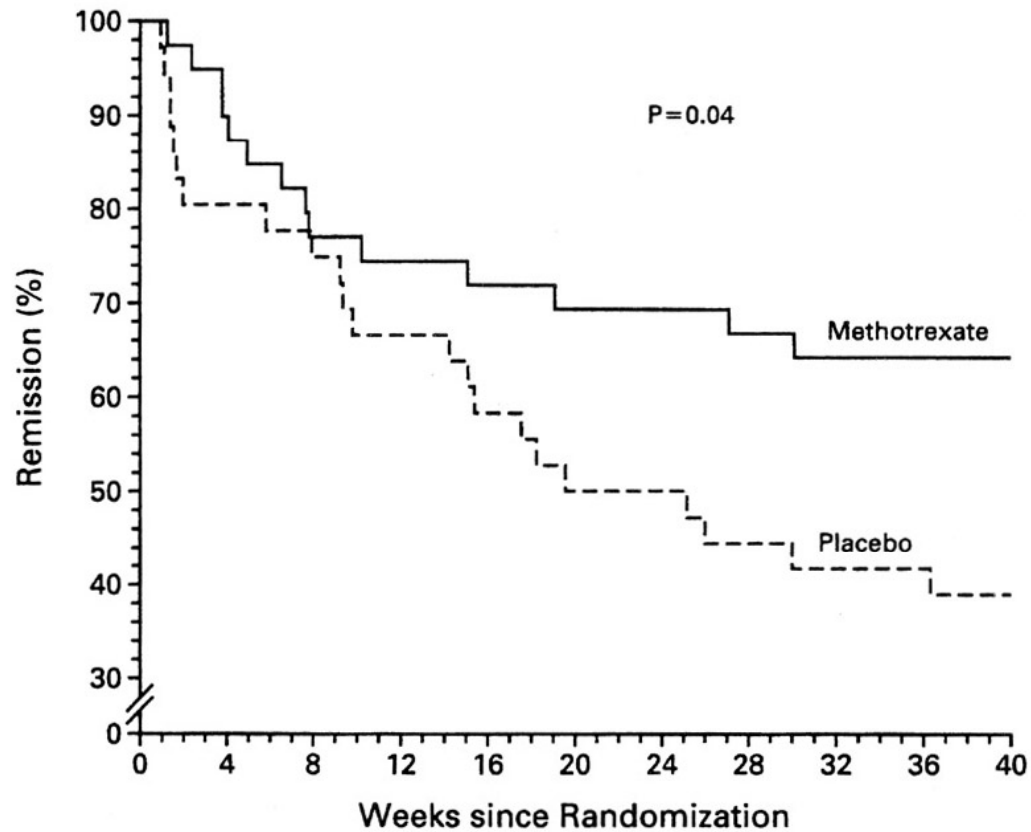
- Logically answer the research question
- Correlate with the methods
- Use data from this study only (exact P values, confidence intervals)
- Present all the representative data
- Use tables, graphs, photographs, and drawings for data
- Write topic sentences for paragraphs, ie,
“Mortality rate for patients who underwent heart transplantation was higher than for patients who underwent LVAD implantation. Twelve transplant patients died.... Five patients who underwent LVAD implants died....”

Table 1. Characteristics of Subjects Who Could Be Evaluated and Those Who Were Analyzed.

Characteristic	Group That Could Be Evaluated (N=4404)	Analyzed Subgroup (N=2507)
Age		
Mean — yr	68.6	69.5
50–59 yr — no. (%)	570 (12.9)	210 (8.4)
60–69 yr — no. (%)	1971 (44.8)	1150 (45.9)
70–79 yr — no. (%)	1678 (38.1)	1025 (40.9)
≥80 yr — no. (%)	185 (4.2)	122 (4.9)
Male sex — no. (%)	1963 (44.6)	1115 (44.5)
Race or ethnic group — no. (%)		
White	3846 (87.3)	2180 (87.0)
Black	369 (8.4)	217 (8.7)
Other	189 (4.3)	110 (4.4)
Family history of colorectal cancer — no. (%)	615 (14.0)	348 (13.9)

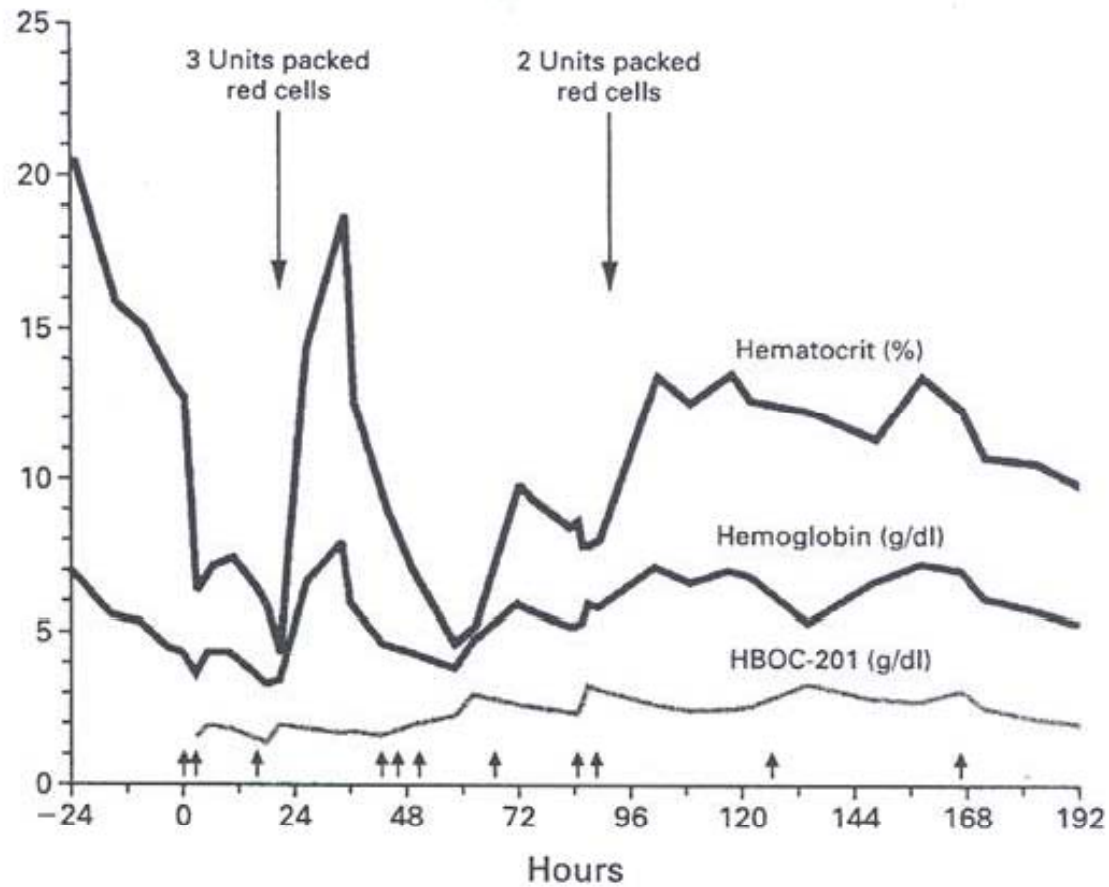


Trial profile that shows patient assignment to the different arms of the study.

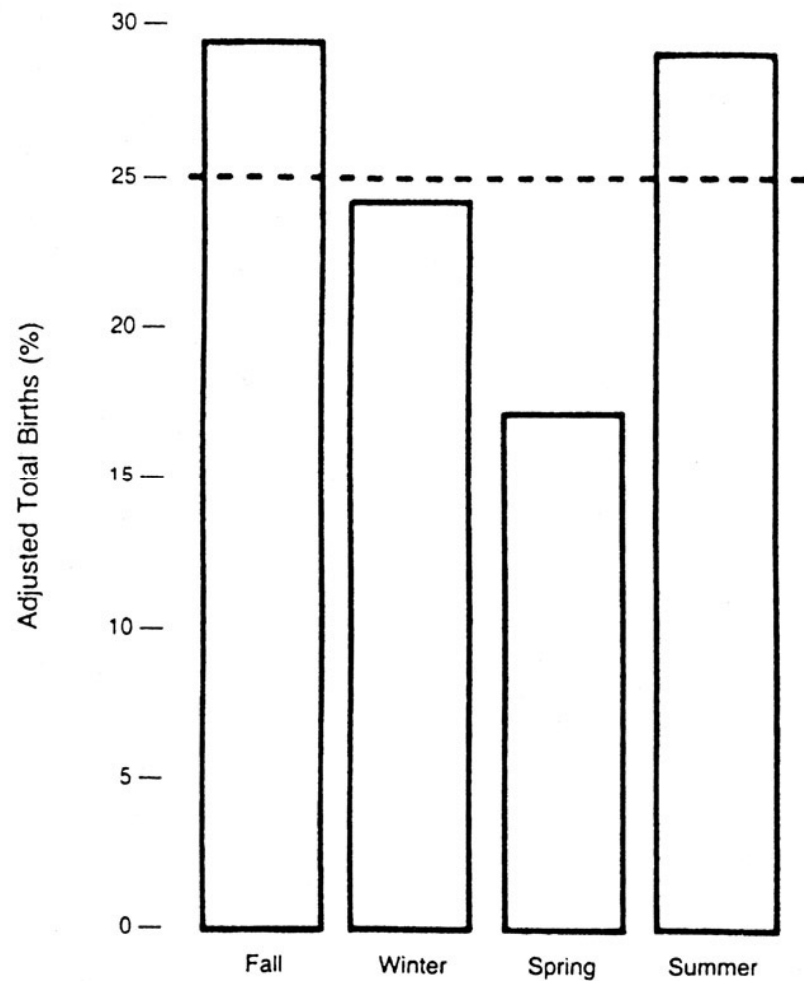


No. AT RISK	
Methotrexate	40 36 30 29 28 27 27 26 25 24 19
Placebo	36 29 28 24 21 18 18 16 15 15 12

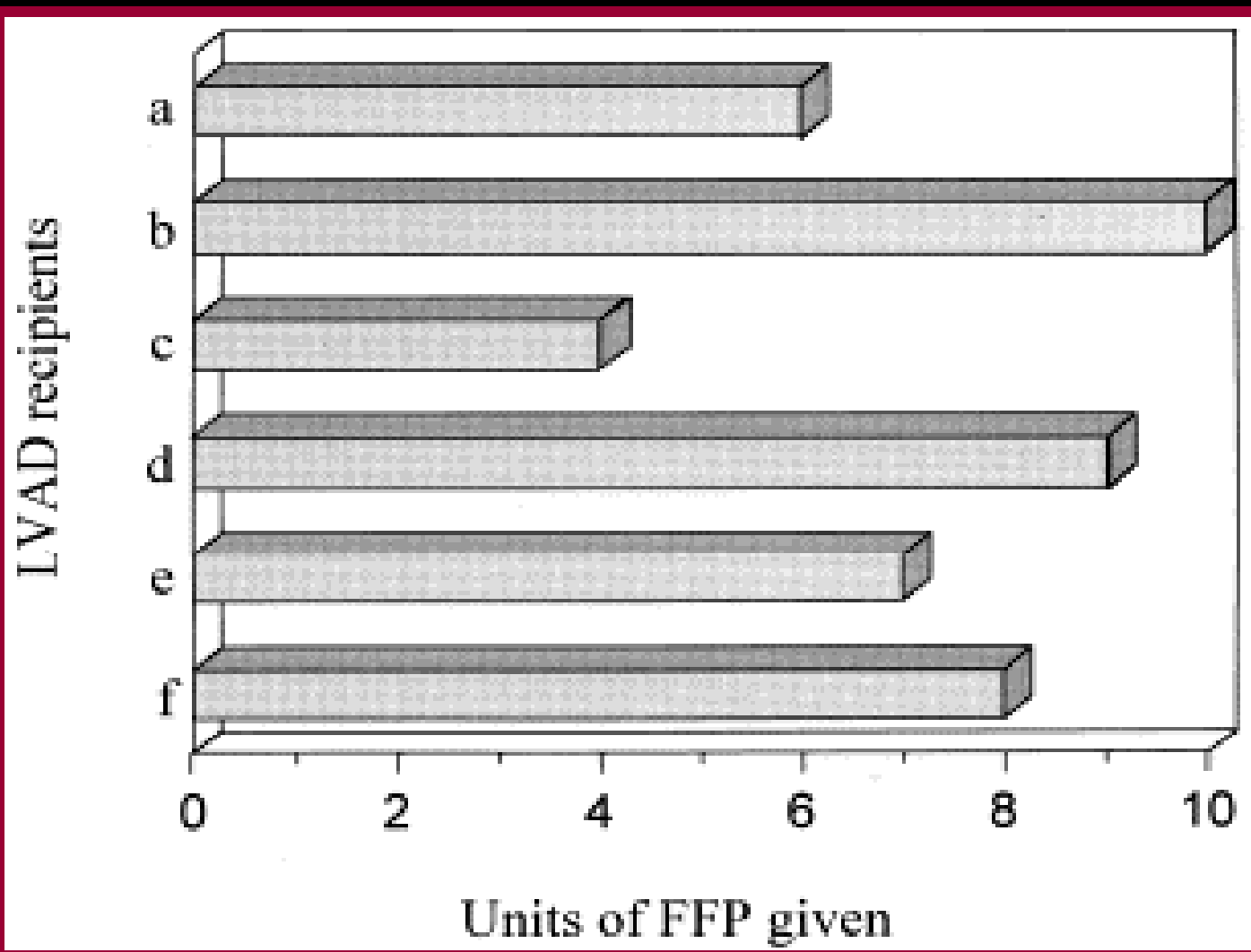
Kaplan-Meier estimates of the time to relapse in patients given methotrexate and placebo, shown in a line drawing.



Hematocrit, hemoglobin, and calculated HBOC-201 levels, presented graphically. These data would be impossible to present in the text.

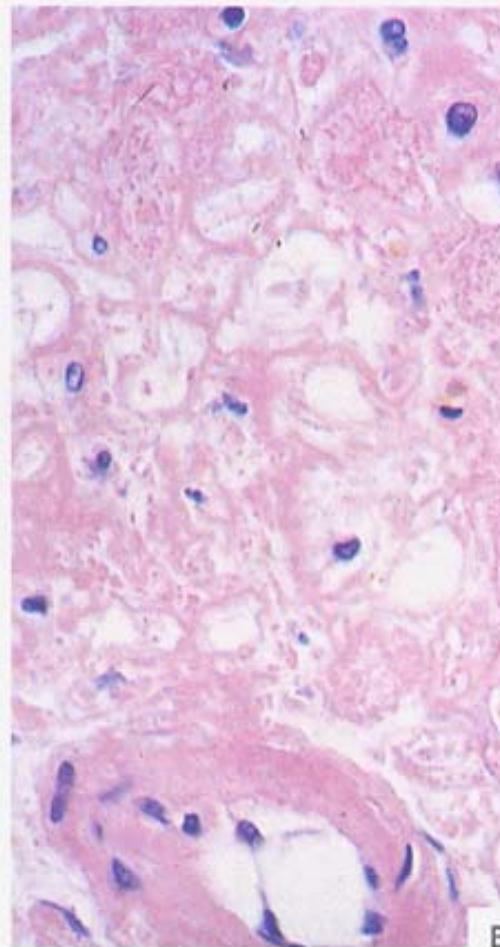


Adjusted births by season, as a percentage of adjusted total births in all seasons, shown by a bar graph.

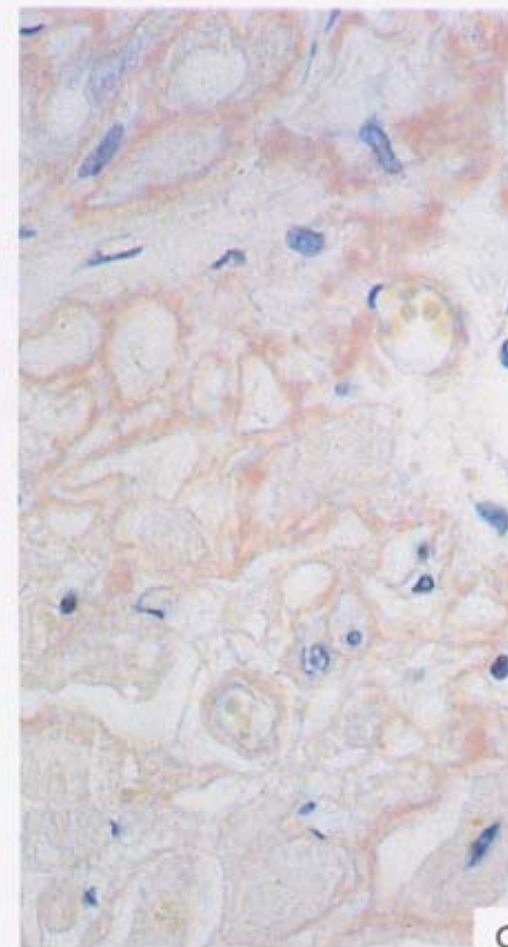




A



B



C

FIGURE 2.73 • Long axis section through a heart with amyloid disease demonstrates the sandy appearance of the left atrial endocardium (A). Histologic section shows myocardial cell degeneration and extensive extracellular deposition of amorphous material enclosing

the cells (B). The amyloid stains positive with a Congo red stain (C). (Reproduced with permission. Hurst JW, Anderson RH, Becker AE, et al: *Atlas of the Heart* New York, NY: Gower Medical Publishing; 1988:5.18.)

RESULTS

- Supplement rather than repeat data in visuals and tables
- Data agree within the section and with data given in other sections and visuals
- Avoid overwhelming the reader with data:
The mean resting blood pressure was 10% higher in the 30 tennis players (94 ± 3 mmHg) than in the 20 control subjects (85 ± 5 mmHg; $P < .05$).
- Should be simply stated (past tense)
- Common errors: discussing results, missing data

QUANTIFICATION OF BENEFITS, COVERAGE OF ADVERSE EFFECTS AND COSTS, AND DISCLOSURE OF TIES WITH INDUSTRY IN MEDIA STORIES, ACCORDING TO DRUG.*

CHARACTERISTIC OF STORY	TOTAL		ALENDRONATE		PRAVASTATIN		ASPIRIN	
	% (no./total no.)	95% CI	% (no./total no.)	95% CI	% (no./total no.)	95% CI	% (no./total no.)	95% CI
Did not quantify benefits	40 (83/207)	33-47	57 (40/70)	45-69	13 (9/70)	6-23	51 (34/67)	38-63
Quantified benefits								
Only relative benefits	83 (103/124)	75-89	87 (26/30)	69-96	80 (49/61)	68-89	85 (28/33)	68-95
Only absolute benefits	2 (3/124)	1-7	0 (0/30)	0-12†	0 (0/61)	0-6†	9 (3/33)	2-24
Relative and absolute benefits	15 (18/124)	9-22	13 (4/30)	4-31	20 (12/61)	4-32	6 (2/33)	1-20
Adverse effects and costs								
Adverse effects mentioned	47 (98/207)	40-54	53 (37/70)	41-65	31 (22/70)	21-44	58 (39/67)	46-70
Costs mentioned	30 (63/207)	24-37	21 (15/70)	12-33	30 (21/70)	20-42	40 (27/67)	28-53
Ties with industry								
Cited expert or study	82 (170/207)	76-87	83 (58/70)	72-91	87 (61/70)	77-94	76 (51/67)	64-86
Cited expert or study with tie‡	50 (85/170)	42-58	71 (41/58)	57-82	70 (43/61)	57-82	2 (1/51)	0-10
Disclosed tie§	39 (33/85)	28-50	32 (13/41)	18-48	47 (20/43)	27-66	0 (0/1)	

*CI denotes confidence interval.

†The one-sided 97.5 percent confidence interval is given because the percentage is zero.

‡The story quoted at least one expert or study-group member with a tie, as determined by a search of the published scientific literature.

§The tie was also disclosed in the media story.

DISCUSSION

What do these findings mean?

The answer is in the Discussion.

DISCUSSION

- Present the principles, relationships, and generalizations shown by the Results
- Briefly summarize and discuss—*don't merely repeat*—the results
- Include a beginning, middle, and end
- Write in present tense, active voice—except for results, which are described in past tense
- Discuss other studies only in the context of your results

DISCUSSION

Beginning:

- Answer the research question
- Begin with a signal:
 - We found that...
 - Blood pressure increased in patients who ...
- Give your conclusions, based on your results
- Give your main result first

DISCUSSION

Answer the question from the Introduction

- End of Introduction:

" . . . to test whether abnormal coronary vasoconstriction, detected by hyperventilation testing before angioplasty, increases the likelihood of restenosis."

- Beginning of the Discussion:

"The presence of abnormal coronary vasoconstriction, detected on hyperventilation testing before angioplasty, was associated with an increased likelihood of restenosis in patients with unstable angina and single-vessel coronary disease."

From NEJM 325:1053-7, 1991

DISCUSSION

Middle:

- Interpret your results
- Discuss key studies—only those relevant to your work
- Compare your work with others' work
- Present ambiguous results and discrepancies with others studies objectively
- Explain unexpected findings
- Describe limitations briefly

DISCUSSION

- **Introduce Points With Your Findings**

Example:

“In this study, multivariate analysis revealed that hyperventilation-induced abnormal coronary vasospasm was an independent predictor of restenosis.... Bertrand et al¹⁷ reported less striking differences ...However, the retrospective nature of the study and the uneven distribution of baseline clinical characteristics in their patient population ... could account for the relatively narrow difference in their results.”

DISCUSSION

Compare With Earlier Work

- Own work first:

“The fact that our study was prospective lends support to the evidence¹⁻³ of a causal role of sleep-disordered breathing in hypertension.”

- Others' work first:

“Previous studies¹⁻³ of the hemodynamic effects of intravenous and oral sildenafil . . . have shown a small but consistent decrease in systemic and pulmonary blood pressure . . . The results of this study confirm these findings in men with severe heart disease. In addition, we found that . . . ”

DISCUSSION

End:

- Write a strong conclusion
- Begin with a signal:
In summary; In conclusion
- Mention applications, implications, and speculation, if appropriate
- Suggest future work, if necessary
- Use present tense except when making comparisons to previous studies or results
- Common errors: too much information, too many studies, no transitions

REFERENCES

- Include only significant, published works.
- Remember the reviewers
- Use the correct format
- Consult a current copy of the journal
- Use EndNote whenever possible
- Check original sources
- In text, cite references at names of authors and after ideas, eg, “Jones and Smith⁸ agree with others that people with a high BMI have an increased risk of morbidity⁹ and mortality.¹⁰”

REFERENCES

- Cite grouped references in chronological order
- Number references in tables and figures according to where they are cited in the text
- In text, name 2 authors; use et al (or “and colleagues” for more than 2)
- Obtain permission to cite unpublished data
- Common errors: typos, inaccurate references

ACKNOWLEDGMENTS

Include

- Intellectual assistance
- Technical help, including writing and data analyses
- Special equipment or materials
- Outside financial assistance (including grants, contracts, or fellowships)

PLAGIARISM AND COPYRIGHT INFRINGEMENT

- Learn about US laws (plagiarism, copyright infringement, fair use), which differ from laws and practices in other countries.
 - Take the CME-accredited course on “Ethics, Plagiarism, and the Internet” on the Texas Heart Institute’s website:
<http://texasheart.org/cme>.
- Avoid direct plagiarism, mosaic plagiarism, unacceptable paraphrasing, and insufficient acknowledgment.
 - Do not use the exact wording from another paper in your paper—even when you cite the source.
 - Use quotation marks when you borrow blocks of text.

GENERAL TIPS

- Outline
- Consult a statistician
- Get IRB approval
- Buy Stedman's spell-check software
- Consult grammar and writing websites
- Buy the *AMA Manual of Style*
- Use an editor
- Remember the question

GENERAL TIPS

- Include one thought per sentence, one idea per paragraph
- Keep words simple. Be as succinct as possible.
- Avoid adjectives, too much description. Keep sentences short (~ 22 words)
- Use transitions and key words
- Use subject-verb-object construction and active voice whenever possible, eg, “This study produced four main findings. First, the overall patency rates during the 5 years after OPCAB showed different patterns of decrease based on the grafts used.”

In science, the credit goes to the man who convinces the world, not to the man to whom the idea first occurs.

— Sir Francis Darwin

Thank You!

Marianne Mallia, ELS

832.355.6776

mmallia@heart.thi.tmc.edu

