Anatomy of a Scientific Paper

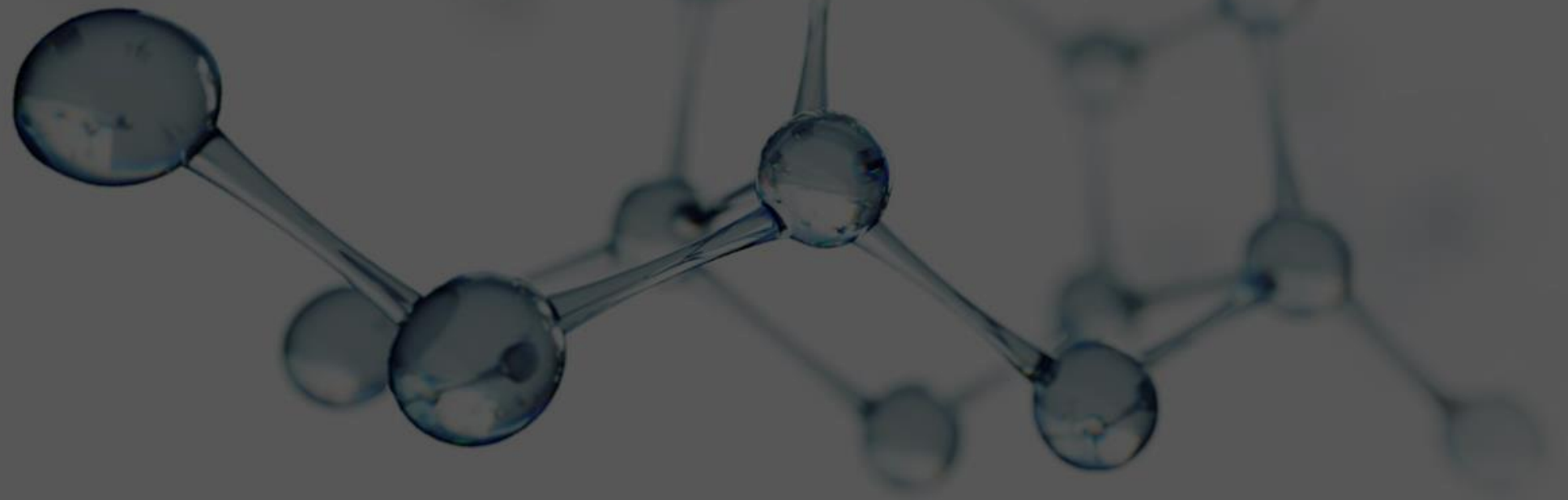
Faheem Guirgis, MD

Research Essentials
6/2/20

Objectives

1. Review the necessary components of a scientific paper
2. Outline the organization of scientific paper content
3. Discuss the requirements of each section
4. Discuss the role of figures and tables in emphasizing and displaying important research data
5. Outline the peer review process and provide tips for success

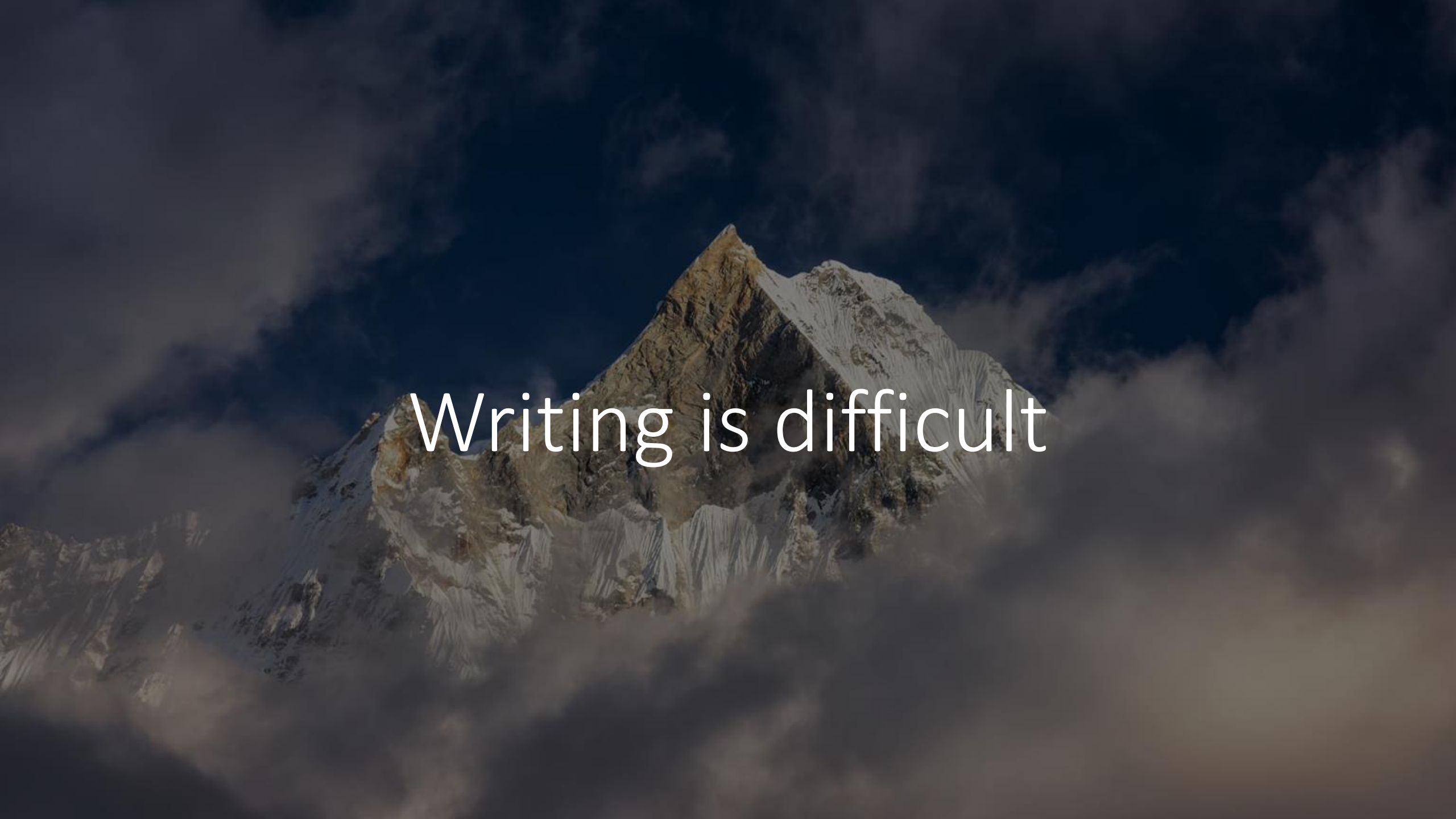
“Papers have both anatomy and physiology, structure and function.“



Gould JC et al. Writing well: lowering the barriers to success. Nature Immunology. Vol 15, No. 8, August 2014.

Why do we write?

Scientific writing for clinicians is problematic


Writing is difficult


Exercise your writing skills

Before you get started

Why do I want to publish?

Is my work publishable?

Before you get started

Decide what type of manuscript to write

Before you get started

Pick a Journal

Before you get started

Review journal requirements in the guide for authors

Before you get started

Pay attention to the structure of the paper

Before you get started

Understand publication ethics to avoid violations.

www.publicationethics.org

Where do I start?

Basic Structure

IMRAD

Basic Structure

Section	Pages	Paragraphs	Words
Introduction	1-1.5	3-4	300-600
Methods	2-3	6-9	750
Results	3	4-9	1000
Discussion	3-4	6-7	1000-1500

Organize Your Writing

Tables/Figures
Methods
Results

Tables and Figures

Tables and Figures

Appropriate title

Make the table legends and captions clear and concise

Define all abbreviations

Use proper units for numeric data

Indicate which statistical tests were used when appropriate

Tables and Figures

Original Investigation

February 26, 2014

Prevalence of Childhood and Adult Obesity in the United States, 2011-2012

Cynthia L. Ogden, PhD[1]; Margaret D. Carroll, MSPH[1]; Brian K. Kit, MD, MPH[1,2]; et al

Author Affiliations | Article Information

JAMA. 2014;311(8):806-814. doi:10.1001/jama.2014.732

Table 1. Unweighted Sample Sizes by Sex, Age, and Race/Hispanic Origin: NHANES 2011-2012

Age, y	All Race/Hispanic Origin Groups[a]	Non-Hispanic White	Non-Hispanic Black	Non-Hispanic Asian	Hispanic
All					
Birth-<2	584	148	144	42	211
2-5	871	160	276	105	282
6-11	1268	299	360	133	403
12-19	1216	269	372	166	350
20-39	1808	630	422	302	381
40-59	1727	582	491	263	347
≥60	1646	687	451	168	309
Male					
Birth-<2	281	80	60	23	103
2-5	439	75	154	44	144
6-11	650	153	175	69	220
12-19	624	144	190	85	172
20-39	941	329	222	154	196
40-59	826	295	215	127	165
≥60	818	337	225	84	154
Female					
Birth-<2	303	68	84	19	108
2-5	432	85	122	61	138
6-11	618	146	185	64	183
12-19	592	125	182	81	178
20-39	867	301	200	148	185
40-59	901	287	276	136	182
≥60	828	350	226	84	155

Table 2. Prevalence of High Weight for Recumbent Length, Birth to 2 Years, United States, 2011-2012[a]

	% (95% CI)	
	≥95th Percentile of CDC 2000 Growth Charts	≥97.7th Percentile of WHO 2006 Growth Charts
Total[b]	8.1 (5.8-11.1)	7.1 (4.9-10.3)
Sex		
Boys	5.0 (3.5-7.0)	3.5 (2.3-5.2)
Girls	11.4 (7.3-17.4)	11.0 (7.0-16.8)
Race/ethnicity		
Non-Hispanic		
White	6.6 (3.8-11.3)	5.5 (2.7-11.1)[c]
Black	8.4 (4.6-14.9)	7.3 (3.8-13.5)
Asian	11.8 (3.7-31.7)[c,d]	9.6 (2.7-28.8)[c,d]
Hispanic	9.4 (5.8-14.9)	8.8 (5.2-14.6)[c]

Abbreviations: CDC, Centers for Disease Control and Prevention; WHO, World Health Organization.

[a] Data from the National Health and Nutrition Examination Survey; estimates are weighted.

[b] Includes race/Hispanic origin groups not shown separately.

[c] Relative standard error >30% (but <40%).

[d] No. of cases <10.

Table 6. Unadjusted Tests of Linear Trends of High Weight for Length[a] and Obesity[b,c] by Age, United States, 2003-2012[d]

	% (95% CI)					Change 2003-2004 to 2011-2012, Point (95% CI)[e]	*P* Value[f]
	2003-2004	2005-2006	2007-2008	2009-2010	2011-2012		
High weight for length (birth-<2 y)							
All	9.5 (7.1 to 12.7)	8.2 (6.1 to 10.9)	9.5 (7.5 to 12)	9.7 (7.6 to 12.3)	8.1 (5.8 to 11.1)	−1.4 (−4.9 to 2.1)	.72
Childhood obesity, 2-19 y							
2-19	17.1 (14.6 to 20)	15.4 (12.8 to 18.5)	16.8 (14.3 to 19.7)	16.9 (15.4 to 18.4)	16.9 (14.9 to 19.2)	−0.2 (−3.4 to 3)	.78
2-5	13.9 (10.8 to 17.6)	10.7 (8.5 to 13.3)	10.1 (7.8 to 12.9)	12.1 (9.9 to 14.8)	8.4 (5.9 to 11.6)	−5.5 (−9.6 to −1.4)	.03
6-11	18.8 (16.2 to 21.7)	15.1 (11.3 to 20.1)	19.6 (17.2 to 22.4)	18.0 (16.3 to 19.8)	17.7 (14.5 to 21.4)	−1.1 (−5.2 to 3.0)	.88
12-19	17.4 (14 to 21.3)	17.8 (14.2 to 22)	18.1 (14.7 to 22)	18.4 (15.8 to 21.3)	20.5 (17.1 to 24.4)	3.1 (−1.7 to 7.9)	.20
Adult obesity, ≥20 y							
≥20	32.2 (29.7 to 34.8)	34.3 (31.5 to 37.3)	33.7 (31.5 to 36.1)	35.7 (33.8 to 37.7)	34.9 (32 to 37.9)	2.8 (−0.8 to 6.4)	.09
20-39	28.5 (25.3 to 31.9)	29.1 (25 to 33.7)	30.7 (26.6 to 35.1)	32.6 (29 to 36.4)	30.3 (26.6 to 34.4)	1.9 (−2.8 to 6.6)	.20
40-59	36.8 (33 to 40.8)	40.4 (36.1 to 44.7)	36.2 (32.8 to 39.8)	36.6 (34.5 to 38.7)	39.5 (36.1 to 43)	2.7 (−2.1 to 7.5)	.78
≥60	31.0 (28.2 to 33.9)	33.4 (31.1 to 35.9)	35.1 (32.9 to 37.3)	39.7 (36.6 to 42.9)	35.4 (31.3 to 39.6)	4.4 (−0.3 to 9.1)	.004

[a] High weight for length defined as at or above the 95th percentile on the sex-specific Centers for Disease Control and Prevention (CDC) 2000 growth charts.

[b] Obesity for youth aged 2 to 19 years defined as body mass index (BMI) at or above the 95th percentile on the CDC sex-specific BMI for age growth charts.

[c] Obesity in adults defined as BMI ≥30.

[d] Data from the National Health and Nutrition Examination Survey.

[e] Percentage points.

[f] From the *t* test.

JAMA | Preliminary Communication | CARING FOR THE CRITICALLY ILL PATIENT

Effect of Vitamin C Infusion on Organ Failure and Biomarkers of Inflammation and Vascular Injury in Patients With Sepsis and Severe Acute Respiratory Failure

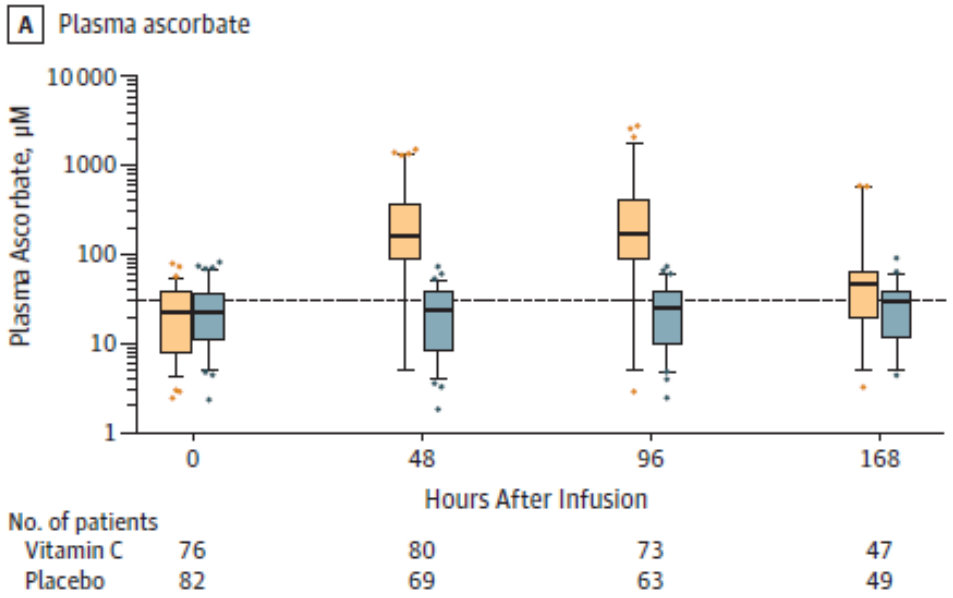
The CITRIS-ALI Randomized Clinical Trial

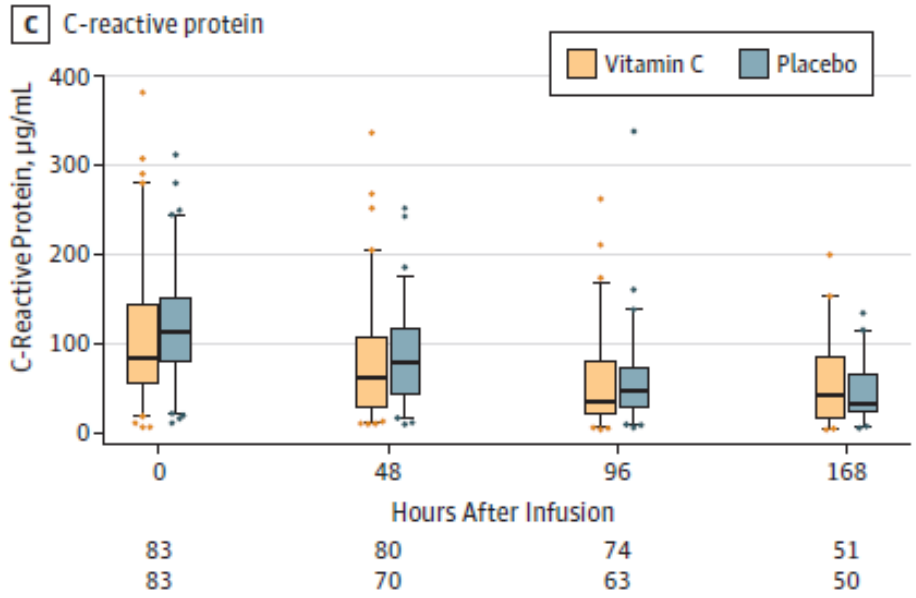
Alpha A. Fowler III, MD; Jonathon D. Truwit, MD; R. Duncan Hite, MD; Peter E. Morris, MD; Christine DeWilde, RN, PhD; Anna Priday, BS, MS; Bernard Fisher, BS, MS; Leroy R. Thacker II, PhD; Ramesh Natarajan, PhD; Donald F. Brophy, PharmD; Robin Sculthorpe, RPh; Rahul Nanchal, MD; Aamer Syed, MD; Jamie Sturgill, PhD; Greg S. Martin, MD, MSc; Jonathan Sevransky, MD, MHS; Markos Kashiouris, MD, MPH; Stella Hamman, RN, MSN; Katherine F. Egan, BSN, RN, CCRC; Andrei Hastings, MD; Wendy Spencer, RN, CPN; Shawnda Tench, BBA, CCRP; Omar Mehkri, MD; James Bindas, MBA; Abhijit Duggal, MD; Jeanette Graf, BS, CCRP; Stephanie Zellner, MS, CCRC; Lynda Yanny, RN, BSN, CCRC; Catherine McPolin, RN, BSN, CCRP; Tonya Hollrith, RT, MR; David Kramer, MD; Charles Ojielo, MD; Tessa Damm, DO; Evan Cassity, MS; Aleksandra Wieliczko, RN; Matthew Halquist, PhD

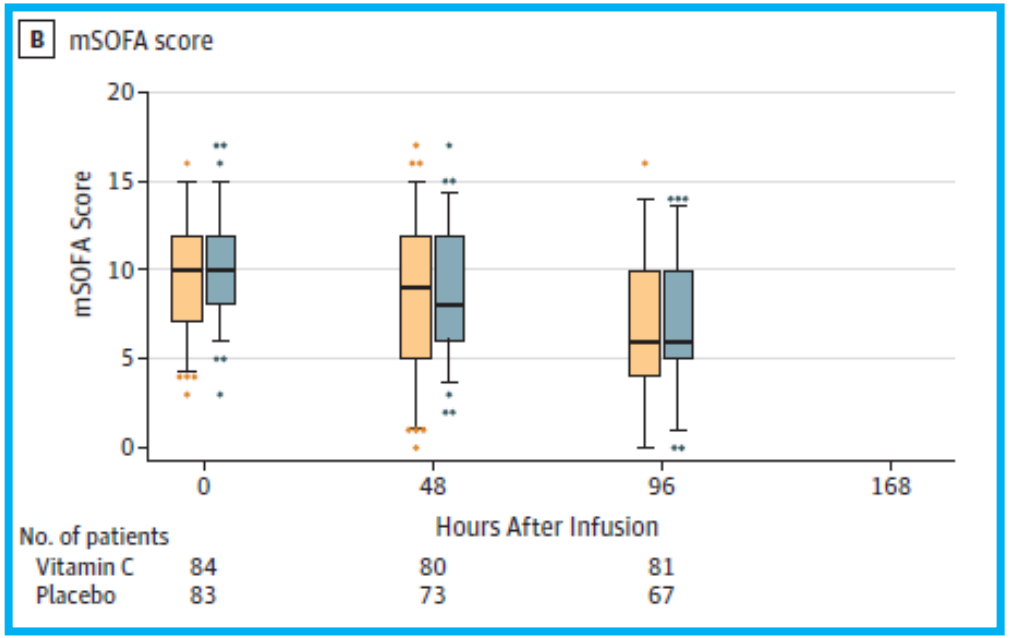
Table 1. Baseline and Follow-up Characteristics of All Patients

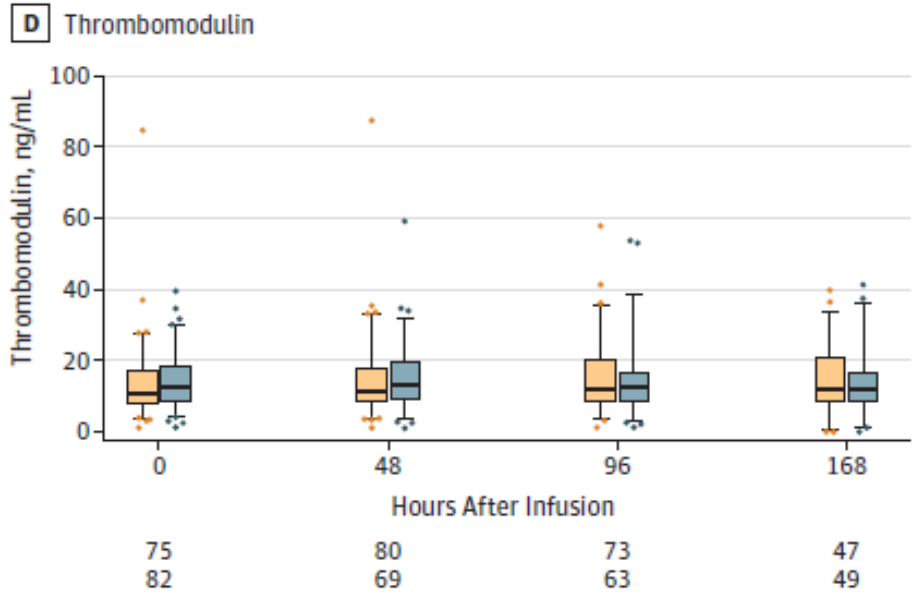
Variable	Vitamin C (n = 84)	Placebo (n = 83)
Demographic data, No. (%)		
Age, median (IQR), y	54 (39-67)	57 (44-70)
Men	45 (54)	45 (54)
Women	39 (46)	38 (46)
Non-Hispanic white	68 (81)	60 (72)
Non-Hispanic black	13 (15)	19 (23)
Hispanic/Asian/ Pacific Islander	3 (4)	4 (5)
Sepsis etiology, No. (%)		
Thorax	69 (82)	58 (70)
Abdomen	6 (7)	13 (16)
Urinary tract	3 (4)	2 (2)
Central nervous system	1 (1)	3 (4)
Central venous catheter	0	1 (1)
Unknown/other	5 (6)	6 (7)
Admission source, No. (%)		
Emergency department	39 (46)	36 (43)
Outside hospital transfer	26 (31)	28 (34)
Inpatient ward transfer	17 (20)	18 (22)
Operating room	1 (1)	1 (1)
Direct admission	1 (1)	0
Incidence of shock, No. (%)		
At baseline, vasopressor in use	57 (68)	60 (72)
mSOFA scores,[b] mean (SD)		
At randomization	9.8 (3.2)	10.3 (3.1)
At 96 h	8.02 (4.2)	6.96 (3.5)
Corticosteroid use during study, No. (%)	56 (67)	54 (65)
IV fluids, mL/kg/24 h		
Day 1, mean (SD)	40 (28.5)	42.6 (35.5)
Day 7, mean (SD)	32.8 (19.6)	33.9 (16.8)
Day 1, median (IQR)	35.1 (21.2-50.3)	33.9 (20.2-55.3)
Day 7, median (IQR)	26.5 (19.7-40.9)	26.8 (16.7-38.3)
Urine output, mL/kg/24 h		
Day 1, mean (SD)	14.1 (14.5)	10.5 (11.7)
Day 7, mean (SD)	24.4 (24.9)	24.6 (22.9)
Day 1, median (IQR)	9.9 (3.9-20)	6.7 (1.7-15)
Day 7, median (IQR)	18.2 (1.5-36)	20.9 (6.1-34.4)

Figure 2. Plasma Ascorbate Concentrations, Modified Sequential Organ Failure Assessment Score, and Plasma Biomarkers

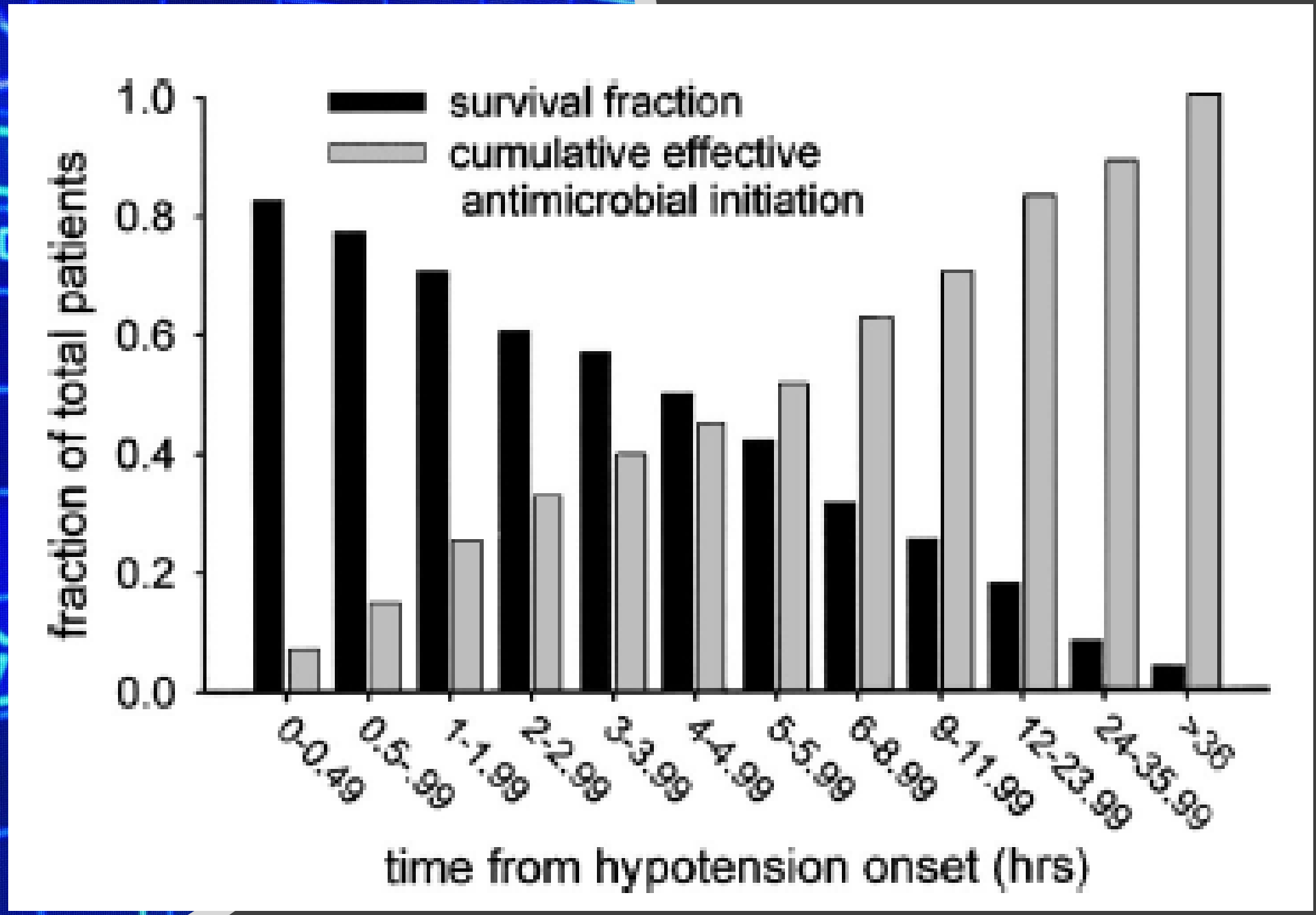






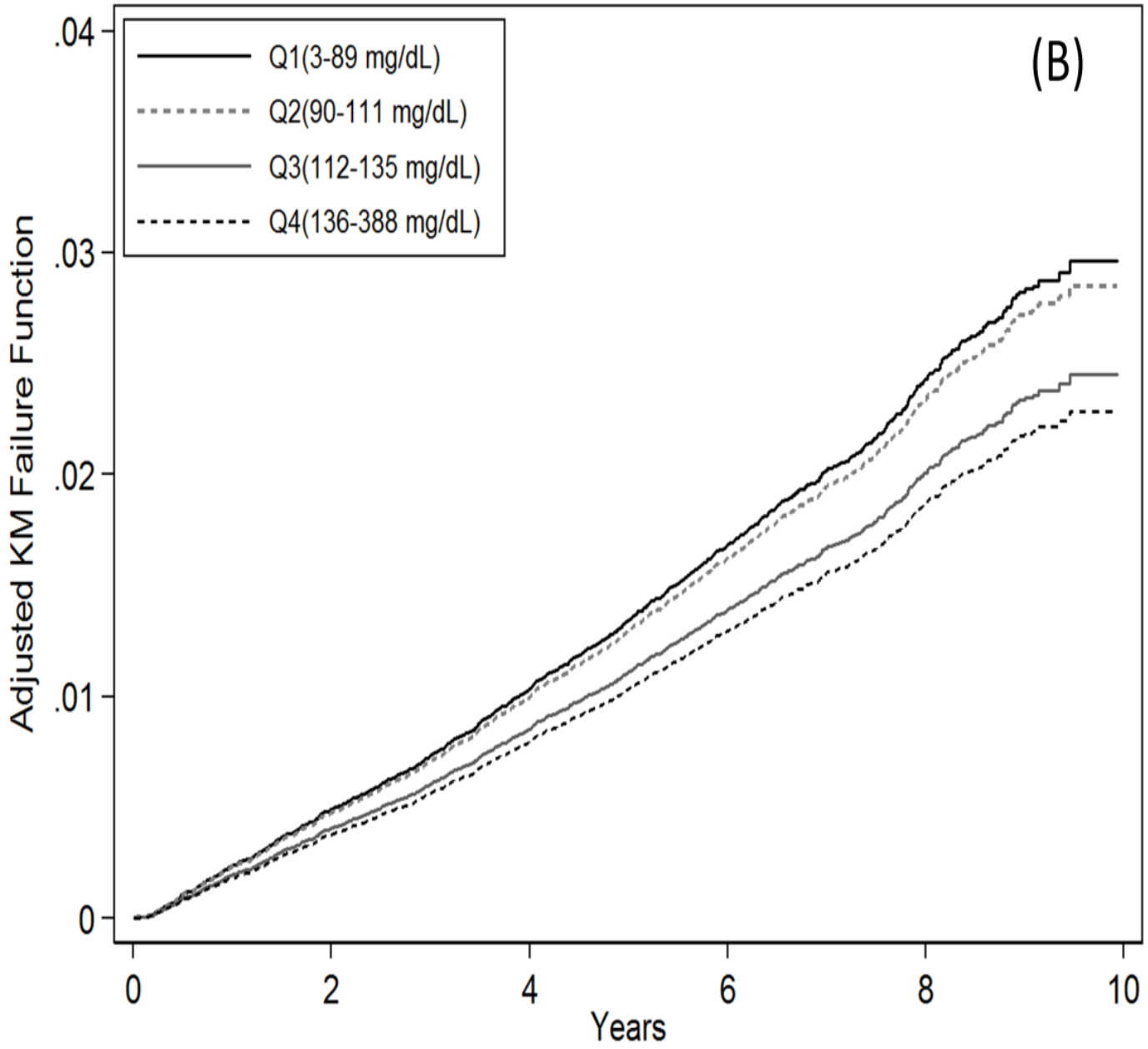


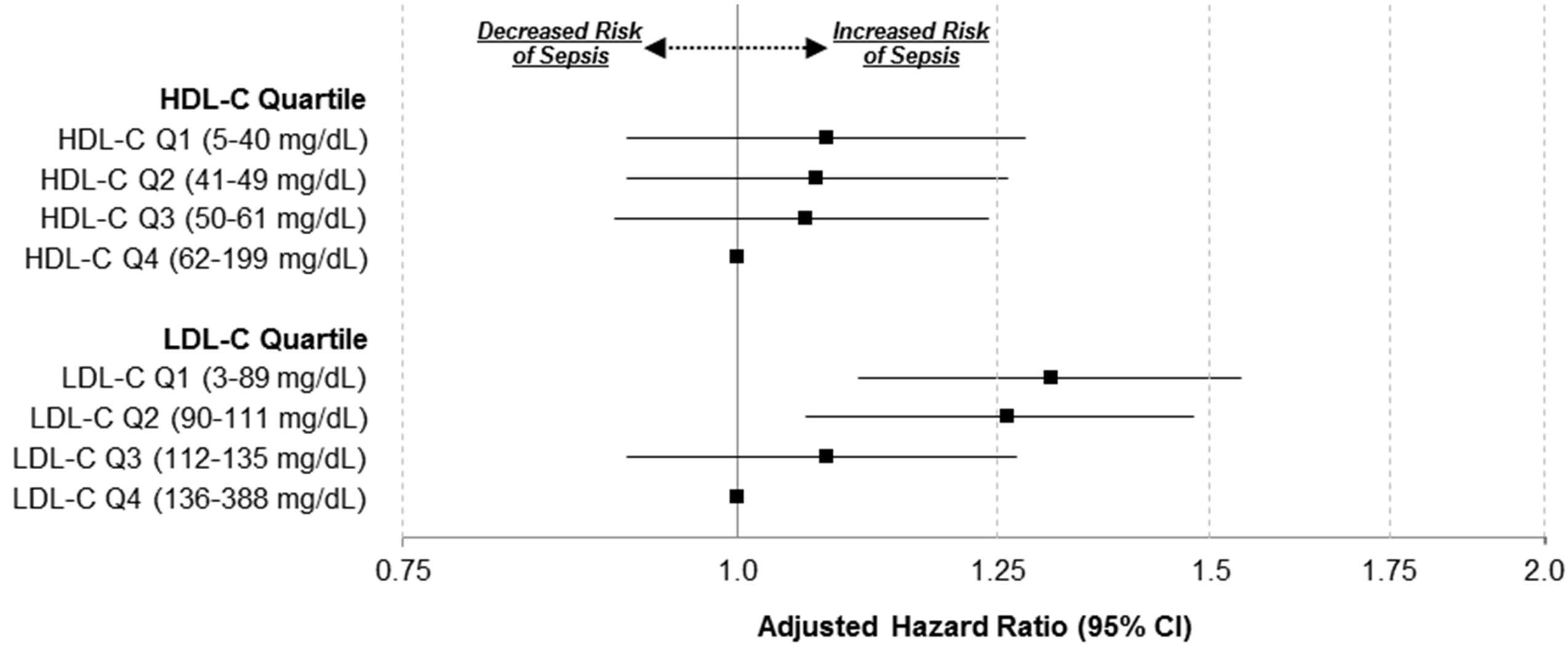
Figures

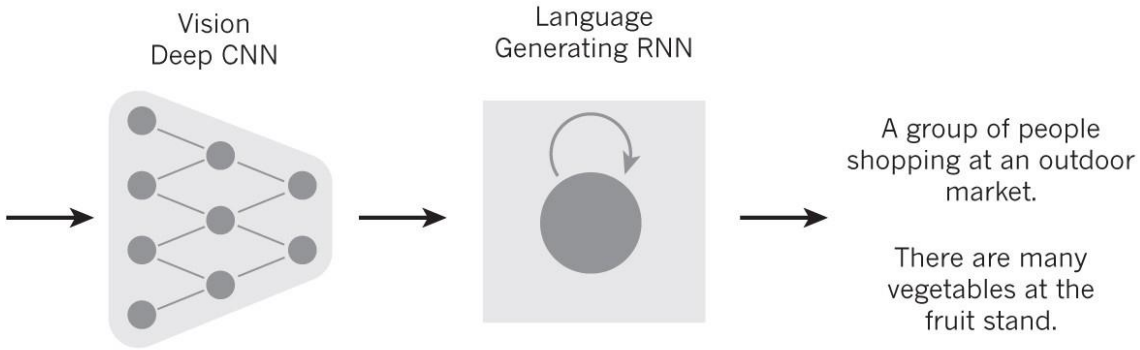


Kumar et al. Crit Care Med 2006 Vol. 34, No. 6

LDL-C Quartiles




Decreased Risk of Sepsis
Increased Risk of Sepsis
HDL-C Quartile
HDL-C Q1 (5-40 mg/dL)
HDL-C Q2 (41-49 mg/dL)
HDL-C Q3 (50-61 mg/dL)
HDL-C Q4 (62-199 mg/dL)
LDL-C Quartile
LDL-C Q1 (3-89 mg/dL)
LDL-C Q2 (90-111 mg/dL)
LDL-C Q3 (112-135 mg/dL)
LDL-C Q4 (136-388 mg/dL)
0.75
1.0
1.25
1.5
1.75
2.0
Adjusted Hazard Ratio (95% CI)



LeCun Y, et al. Deep Learning. Nature volume 521, p. 436–444 (2015).

A woman is throwing a **frisbee** in a park.

A **dog** is standing on a hardwood floor.

A **stop** sign is on a road with a mountain in the background

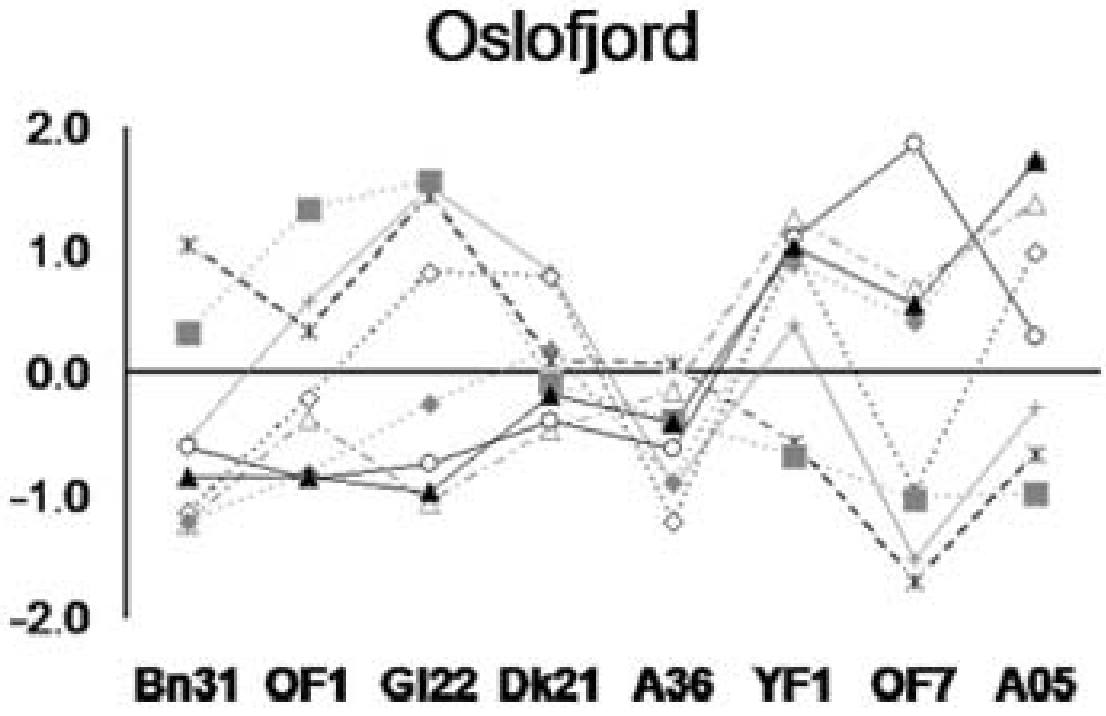
A little **girl** sitting on a bed with a teddy bear.

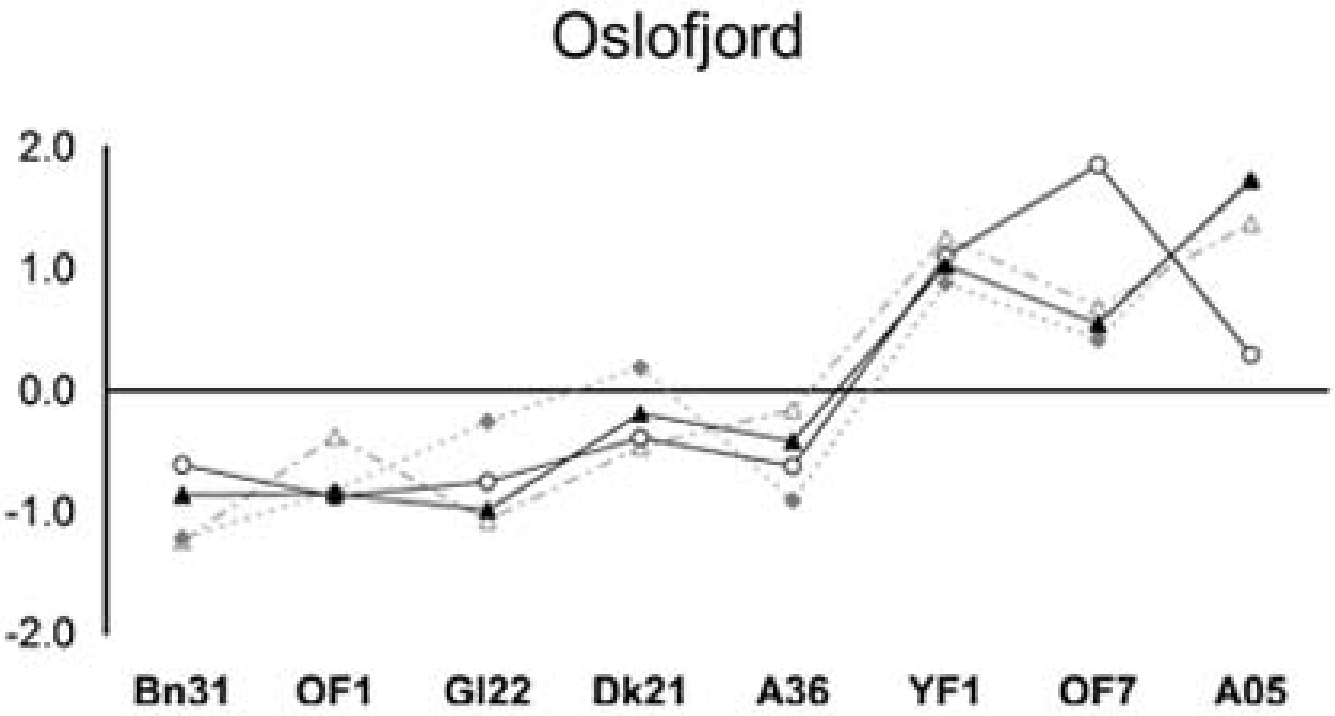
A group of **people** sitting on a boat in the water.

A giraffe standing in a forest with **trees** in the background.

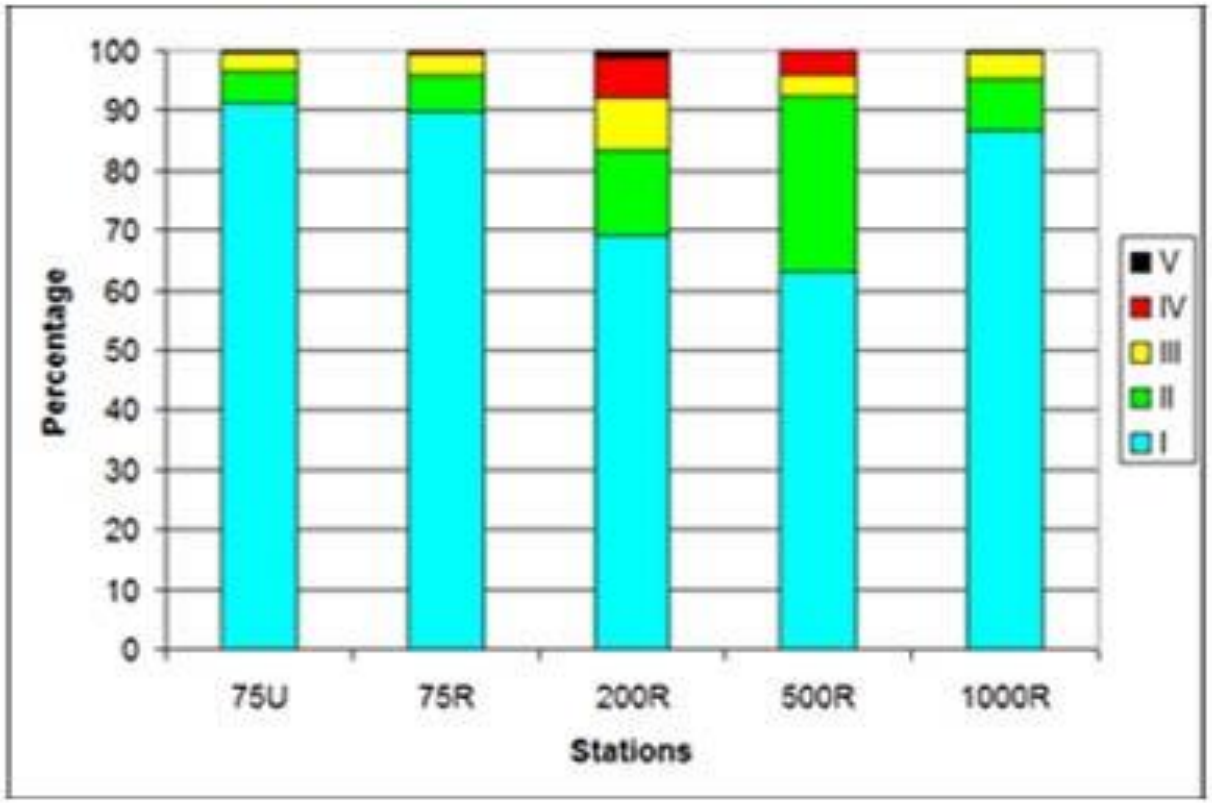
Figure Tips

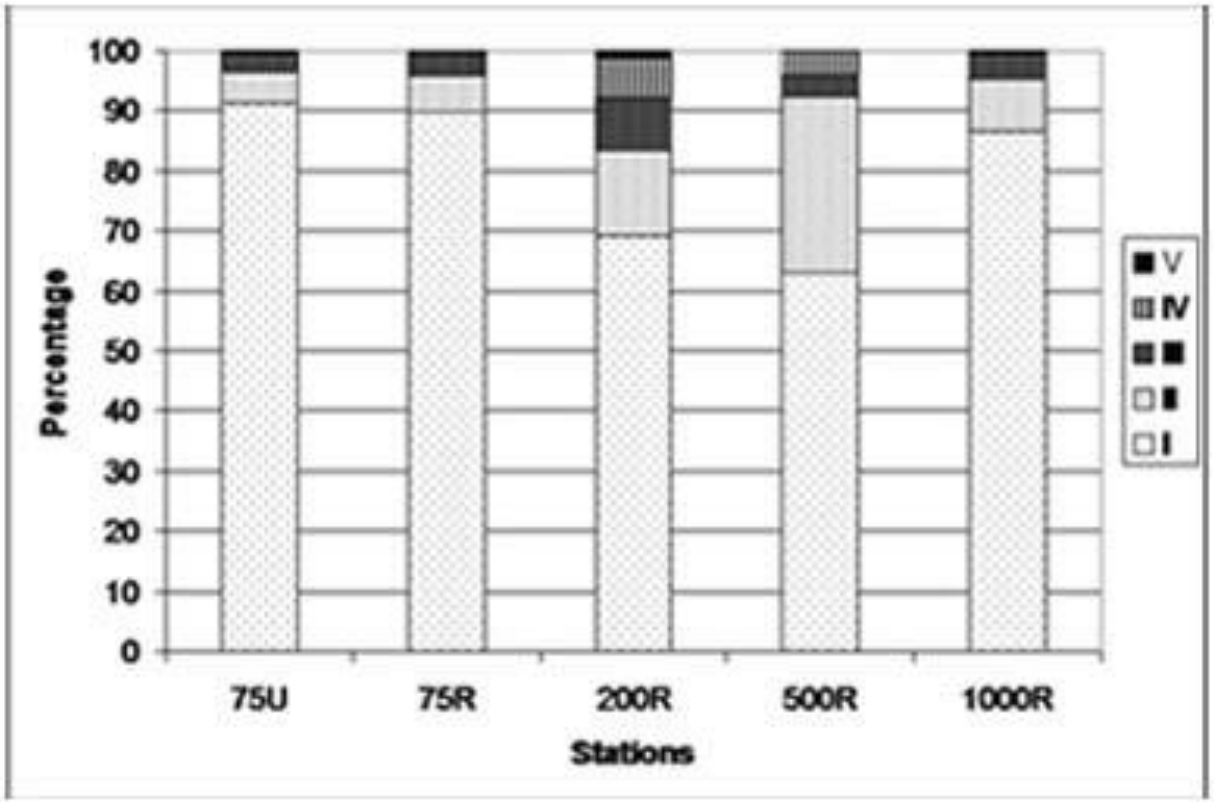
Don't clutter your charts with too much data



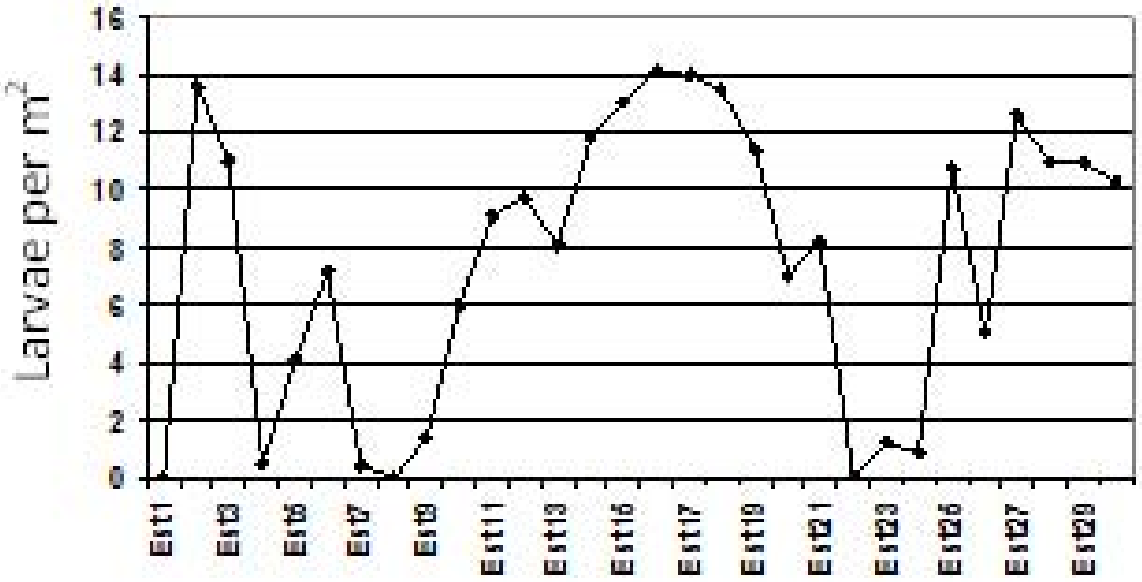


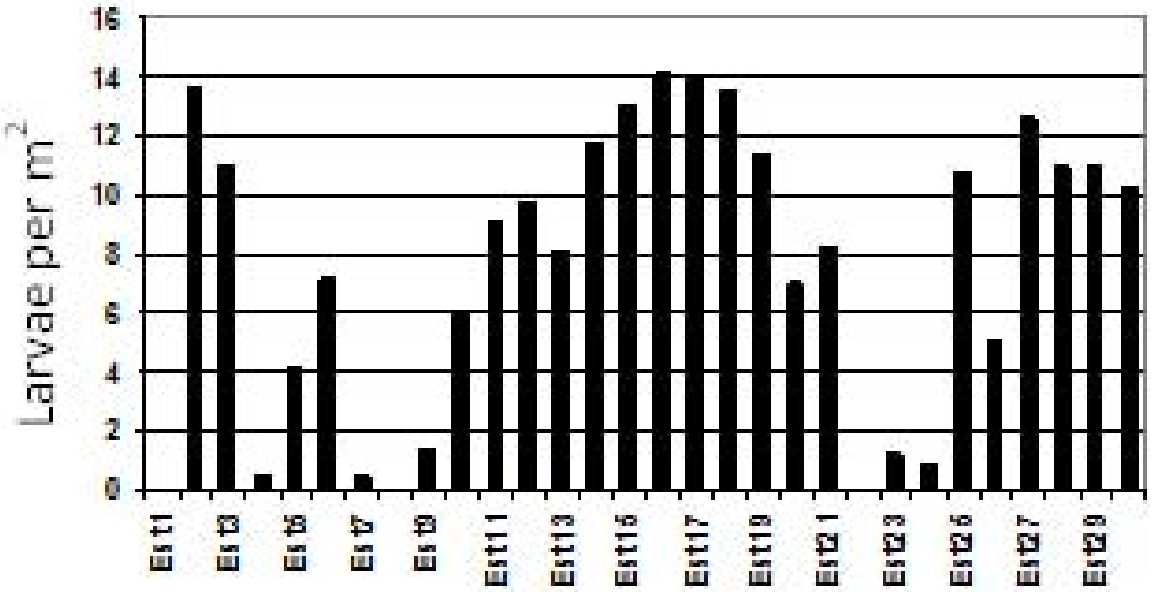
Using black and white for print can save money





Use the right kind of chart





Methods

Methods

Study Setting/Design
Study Patients
Interventions (if applicable)
Data Collection
Outcomes
Statistical Methods

Interventions

Consent

Randomization

Blinding

Drug administration

Assessments (blood draws, surveys, physical exam findings)

Data collection

What data was collected, how, by whom?

Data management and storage

Adjudication/Validation

Agreement (Kappa or % agreement)

Outcomes

Primary Outcome = e.g., survival, pain score, peak flow improvement for asthma

Secondary Outcomes = e.g., hospital length of stay, ICU length of stay, 28-day mortality, time to discharge

Stats Methods

Sample Size and Power

Analytic plan, univariate testing, multivariate testing

Software used

Results

Data vs. Results

Data	Results
Are the facts obtained from experiments or observations	The meaning and interpretation of data

Data vs. Results

Data	Results
Are the facts obtained from experiments or observations	The meaning and interpretation of data
Can be presented as raw, summarized or transformed	Statements that explain or summarize what the data show

Data vs. Results

Data	Results
Are the facts obtained from experiments or observations	The meaning and interpretation of data
Can be presented as raw, summarized or transformed	Statements that explain or summarize what the data show
Rarely stand alone	May have a direction (positive or negative) or magnitude (10% increase)

Data vs. Results

Data	Results
Are the facts obtained from experiments or observations	The meaning and interpretation of data
Can be presented as raw, summarized or transformed	Statements that explain or summarize what the data show
Rarely stand alone	May have a direction (positive or negative) or magnitude (10% increase)
No tests of significance	May contain statistical significance (p-value)

Data vs. Results

Data	Results
Are the facts obtained from experiments or observations	The meaning and interpretation of data
Can be presented as raw, summarized or transformed	Statements that explain or summarize what the data show
Rarely stand alone	May have a direction (positive or negative) or magnitude (10% increase)
No tests of significance	May contain statistical significance (p-value)
E.g. mean fasting blood glucose was 180 mg/dL in DM pts, and 95 mg/dL in non-DM	E.g. mean fasting blood glucose was higher in type 1 DM patients compared to non-DM patients (180 (20) vs 95 (5), p = 0.03).

Results

Results should be presented in a logical manner

“General to specific” is the most common format for clinical studies

Univariate followed by multivariate results

Results

Example
P1: Study participants, general descriptors
P2: Univariate results for control group, followed by experimental group
P3: Paragraph on important figure 1 or table
P4: Multivariate results
P5: Secondary pertinent findings

There were 30% of patients who had DM (30/100), 22% who had COPD, 15% who had hyperlipidemia…

The most common comorbid condition was DM, followed by COPD, and hyperlipidemia (Table 1)

Primary Outcome

The mean SOFA score from baseline to 96 hours decreased from 11 to 6 (5 points) in the experimental group and from 10 to 7 (3 points) in the placebo group (difference, 2; 95% CI, 1 to 3; *P* = .20). (Table 2)

Results

Use subheadings to keep results of the same type together

Results

Interpret but don’t make inferences about your results

Don’t include references

Results

Use supplemental figures and tables to present secondary data

Don’t attempt to hide data

Discussion

The main function of the discussion section is to answer the research question and to use the results for supporting the answer

Discussion

The purpose of a discussion is to relate the results observed with facts, interpret their meaning, justify their importance and contributions to current scientific literature, and provide specific suggestions for future research

Discussion

P1: Summarize the key findings of the study. Directly answer the questions presented in the Intro.

P2: Interpret the results. State study importance and how it adds to the literature

P3: Compare and contrast to other studies in the field

P4: Discuss secondary pertinent findings

P5: Study Limitations

Conclusion

Summarizes and focuses on the main question addressed in the study and links it to the objectives

Short paragraph (3-5 sentences)

Conclusion

Must be supported by data

Conclusion

Strong, clear, concise

Conclusion

Clearly state whether the findings support the hypothesis or not

Introduction

Summary of relevant literature and background knowledge

Introduction

Highlight the gap of knowledge

Introduction

States the research question or hypothesis and defines the objectives of the study

Introduction

Describes the methodological approach used to fill in the gap and respond to the question

Abstract

Background/Objective, Methods

Results, Conclusion

Grab the reader's attention with the first statement

Limited to the most important information

The Title

Simple

Specific

Not overly technical

Concise

Final pieces

Keywords for indexing

Acknowledgements

References

Peer Review

Always be polite

Make it easy for both editors and reviewers

Acceptable to include additional data or references that strengthen your argument

Top Tips

- Follow the length recommendations
- Avoid turning your Intro into a review article
- Have a clear scientific question
- Work on tables and figures first
- Be true to your data in results/discussion
- Don’t try to milk two papers out of one
- Practice writing
- Have others proof-read your work and provide feedback
- Review for a journal

References

Borja A. 11 steps to structuring a science paper editors will take seriously. *Elsevier Connect*. June 24, 2014.

Borja A. 6 things to do before writing your manuscript. *Elsevier Connect.* May 12, 2014.

Gould JC, et al. Writing well: Lowering the barriers to success. *Nature Immunology.* Vol 15, No. 8, August 2014.

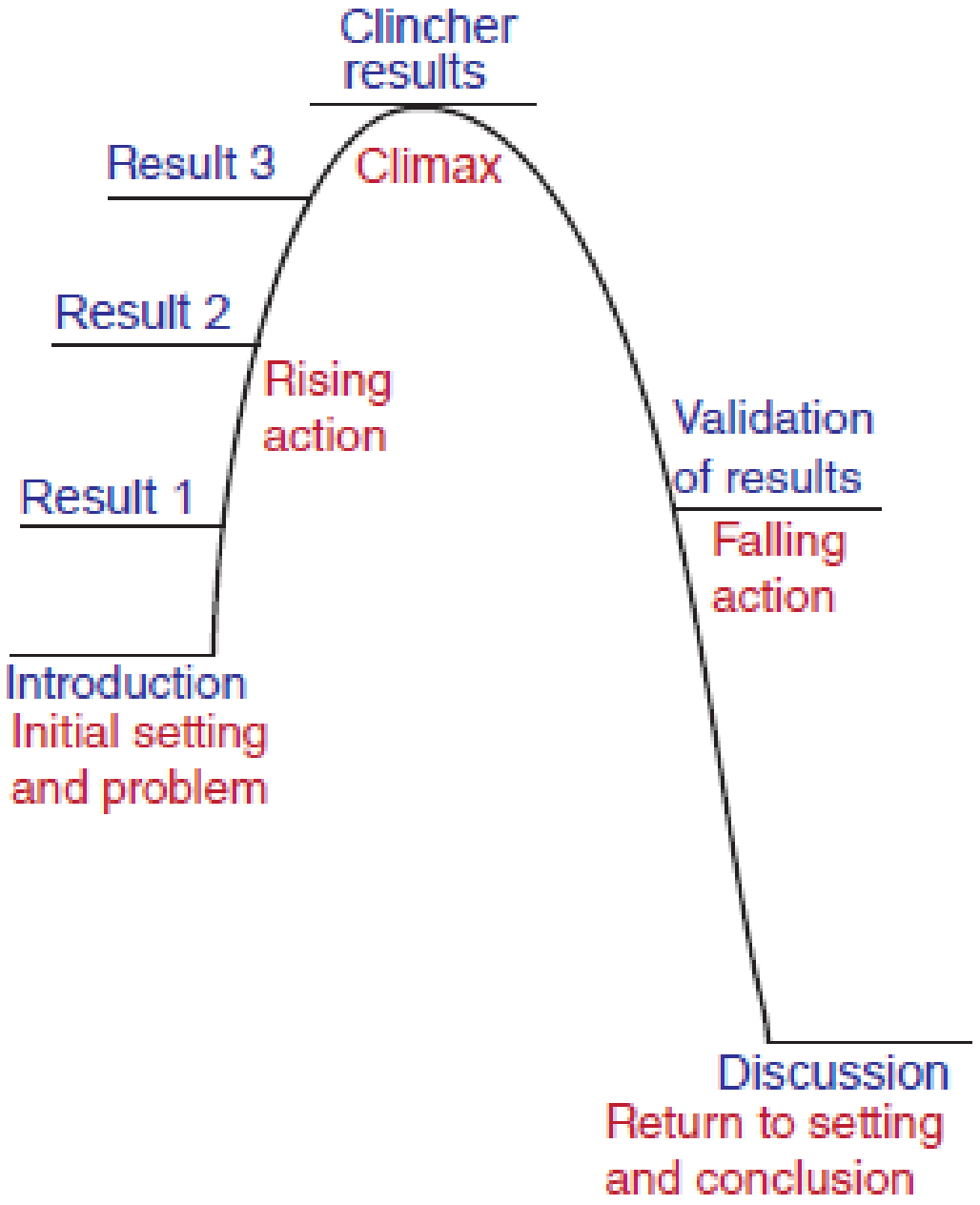
Bahadoran Z, et al. The Principles of Biomedical Scientific Writing: Introduction. *Int J Endocrinol Metab.* 2018; 16 (4) e84795.

Ghasemi A, et al. The Principles of Biomedical Scientific Writing: Methods. *Int J Endocrinol Metab*. 2019; 17(1):e88155.

Bahadoran Z, et al. The Principles of Biomedical Scientific Writing: Results. *Int J Endocrinol Metab.* 2019 April; 17(2):e92113.

Ghasemi A, et al. The Principles of Biomedical Scientific Writing: Discussion. *Int J Endocrinol Metab.* 2019 July; 17(3):e95415.

Faheem.Guirgis@jax.ufl.edu


Clincher
results
Result 3
Climax
Result 2
Rising
action
Validation
of results
Result 1
Falling
action
Introduction
Initial setting
and problem
Discussion
Return to setting
and conclusion