Student Clinical Research Elective Handbook

Summer 2011

Oregon Health and Science University
Department of Radiation Medicine
Knight Cancer Institute

Prepared by

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Dear Summer Student,

You have been invited to participate in Clinical Research in the Department of Radiation Medicine. As part of our team your research will allow continued progression as a junior researcher, helping to hone acumen in both research and patient care.

Student Research in Radiation Medicine is an excellent vehicle for clinical research training. By observing the entire process of the study, from accrual of patients, consent and registration, through statistical evaluation and manuscript preparation, you will be able to observe a scientific endeavor in its entirety over the research term, rather than seeing only portions of a multi-year project. The fact that this investigation is on the cutting edge of radiation oncology investigation only adds benefit to this experience. The training you receive working on this project will similarly be augmented by your ability to participate in daily planning meetings with faculty and house staff. Meet with your research mentor daily and inform him/her of your progress. These meetings will afford constant monitoring of protocol progression, and will be the avenue for future hands-on training in data collection, analysis, and scientific writing, as your project moves towards publication. In addition, high-quality daily clinical conferences, weekly journal clubs, and other formal educational activities of the Department are available, affording not only research growth, but also didactic clinical training in radiation oncology.

Based on previous endeavors with high school and undergraduate students, it is my belief that programs such as this are the optimal method of introducing promising young minds to academic clinical research, while simultaneously teaching skills such as statistical analysis, scientific writing, publication submission, patient interviewing, and critical thinking. We are pleased that you have chosen to participate in research in our Department and wish you the best in your efforts.

Sincerely,

Charles R. Thomas Jr., M.D.
Professor and Chair
Department of Radiation Medicine
Oregon Health and Science University

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Mission

Even the best classroom education cannot fully prepare a student for a real-world work environment, be it an operating room, a research lab, or an office building. The Student Clinical Research Program partially fills that void, allowing students to interact with and learn from leading researchers within a hands-on clinical setting. Whether or not the student pursues a career in radiation oncology, the Student Clinical Research Program strongly believes the experience will benefit the student's professional life.

Student Clinical Research Program is designed to integrate OHSU's research and teaching missions through the creation of faculty/student research partnerships. Involving students in research early in their academic careers enhances their academic experience. Further, the program enables faculty and research scientists to mentor students through a common focus – clinical research. Engaging bright and enthusiastic students in our clinically-related research introduces them to the culture of our discipline, modes of inquiry and discourse in our discipline along with the methodology and ethical issues confronted in our discipline.

Students build research skills they can utilize in all aspects of their academic careers, find coursework more relevant, and gain a sense of engagement in the respective institutions. Through this partnership, faculty help develop the next generation of researchers and scholars. In turn, these students will assist faculty with their research activities, bring a fresh eye to their work, and provide new insights and perspectives.

Program description

The Department of Radiation Medicine Student Clinical Research Program is a non-credit, ten-week minimum, structured clinical research experience. The program consists of "hands-on" clinical research experience with an investigator serving as a mentor, role model and advisor. The program is designed to provide participants in-depth exposure to actual clinical scientific research in the hopes that the excitement, challenge and creativity of the enterprise will convince them to consider clinical research in the sciences as a viable career choice. The program:

1. Provides an opportunity and atmosphere in which students may test theory learned in the classroom in an actual working situation and discover the value of work and the rewards of accomplishment
2. Enhance educational aspects of the career development process
3. Provide a system of accountability and encourage professionalism
4. Provide an opportunity for students to develop positive work habits
5. Provide an opportunity to test aptitude for or interest in radiation medicine

Summer Research Students are **required** to:

1. Wear their OHSU ID at all times when on campus.

Student Eligibility

The Student Clinical Research Program is open to high school and undergraduate students nationwide. The Student Clinical Research Program encourages the participation of students of color and women in the sciences to help retain their interest in their chosen academic endeavor.

Professionalism and Program Dress Code

The Department of Radiation Medicine at the Oregon Health and Science University maintains a professional environment. By working with at least faculty, each student becomes a representative of what we stand, in addition to representing your school as well as your family. Students will encounter patients, medical and professional personnel. All students are thus expected to conduct themselves in a professional, mature, and ethical manner when in the department and at all organized activities. Because the department of is a clinical environment, students are expected to dress in a professional manner.

Suggested Daily Attire for Young Men:

1. Clothing that is clean and professional
2. Casual pants or jeans
3. Light sweaters, clean shirts
4. Professional T-shirts or dress-shirts
5. Tennis shoes, closed-toe and closed-back shoes.

Suggested Daily Attire for Young Women:

1. Clothing that is clean and professional
2. Casual pants, jeans, Capri pants (knee length or lower), or skirts (knee length or lower)
3. Light sweaters, clean shirts
4. Professional T-shirts or dress-shirts
5. Tennis shoes, closed-toe and closed-back shoes, comfortable footwear or shoes good for walking.

Unacceptable Clothing:

1. Hats
2. Shorts
3. Tank tops or spaghetti straps
4. Baggy pants
5. Anything with unnecessary/non-functional holes in it
6. Dirty clothes
7. Headphones in the hallway (Headphones are used only at your desk area)

Suggested Attire for your Final Professional Presentation Session:

1. Business attire is required for the Professional Presentation Sessions.

Cell Phone Usage

Cell phones can be distracting in a clinical/research setting. Please silence your cell phone or put it on vibration mode while working in the department. You may want to answer your calls or texts, but keep the conversation time to a minimum to prevent interference with your work.

Please, advise your relatives or friends to contact you during off-work hours, unless there is an emergency.

Best Practices to ensure a Successful Mentor/Advisor-Student Research Partnership

Adapted from "How to Mentor Undergraduate Researchers" by Carolyn Merkel and Shenda M. Baker.

1. Mentors/advisors shall identify ways to socialize their student into the culture of radiation oncology environment. What is proper clinical etiquette? What are the roles and responsibilities of the various members of your research group? Who can answer what questions? How does one keep track of information/data collection?
2. Mentors/advisors shall provide their students with background reading to help them understand how their piece of the project relates to the larger project.
3. Mentors/advisors shall make clear to their students who can answer what questions in their absence and make sure the members of their research group understand their roles and responsibilities to the students.
4. Mentors/advisors shall set-up regularly scheduled meetings if not weekly, then biweekly. Mentors/advisors shall take a few minutes during each meeting to ask how the students are doing outside of their projects.
5. Mentors/advisors shall make their expectations clear from the beginning, this includes deadlines, best methods of communication, hours of work, timelines, and level of detail require of lab notebooks, etc.
6. Mentors/advisors shall let their students know when they are needed to check in and how much freedom they have to problem solve on their own and be independent.
7. Mentors/advisors shall provide opportunities for their students to take on increasing responsibility and more difficult tasks and responsibilities when they have demonstrated competence.
8. Mentors/advisors shall make time to discuss with their students the ethical issues they may encounter from the fabrication of data to who owns the research, intellectual property, confidentiality, etc.
9. Mentors/advisors shall let students know there will be ups and downs in the research process and that there are many tedious moments in research, failures, etc. as well as exciting moments.
10. Mentors/advisors shall make some time on occasion to talk to the student about life outside the research project, how things are going in their classes, personal goals, adjustment to campus, etc. This means a great deal to a student when a mentor/advisor takes an interest in him/her as a person.

Prepare to Meet with Your Mentor/Advisor

During your meeting with your mentor/advisor, you may want to find out some more information about the expectations for you as a summer student. These expectations may differ from mentor/advisor to mentor/advisor. Getting answers to your questions will also ensure that the mentor/advisor or the environment is in fact a good fit for you.

Questions to consider:

1. How many hours would I need to work?
2. Are hours flexible if I have other (academic) obligations?
3. Will I be able to work independently or will I be supervised?
4. Will I be able to work on a project?
5. How many other summer students will I be working with on the same project?
6. What is the end result of the project, if I am assigned one?
7. Are there any papers I must read before starting?
8. What funding opportunities exist?

This list is not meant to be comprehensive. You will undoubtedly have your own unique questions. Remember that these first meetings should really be a discussion of your goals and the mentor/advisor's goals and expectations.

Goals for the Summer Clinical Research Elective…

It is generally understood that a summer experience is a truncated experience. Nevertheless, this does not justify expediency that may consequentially compromise the quality and integrity of your work. With that said:

1. Students are expected to work hard
2. The summer experience is expected to be an enjoyable one
3. Students are expected to reach their mentors/advisors at anytime, irrespective of how busy they might be, with questions and/or concerns, no matter how trivial they might appear to be:
    a. This will prevent issues from becoming potential problems
    b. This will promote efficiency
        i. Tasks should be done once and done right, no matter how long it takes.

At the completion of your summer research elective in the Department of Radiation Medicine, you will:

1. Understand the basic theoretical underpinnings of radiation oncology
2. Have participated in clinical research activities
3. Delivered a 10- to 15- minute presentation detailing research activities and findings, with a brief review of the literature
4. Have prepared an abstract for submission to a national or international meeting [i.e. American Society for Clinical Oncology (ASCO), American Society for Radiation Oncology (ASTRO), European Society for Therapeutic Radiation Oncology (ESTRO), Radiation Research Society (RRS), American Radium Society (ARS), American Association for Physicist in Medicine (AAPM), etc.]
5. Have prepared a manuscript for submission to a reputable peer-reviewed journal [i.e. International Journal of Radiation Oncology • Biology • Physics, Radiotherapy and Oncology, Medical Physics, Medical Dosimetry, Physics in Medicine and Biology, etc.]. Your mentor/advisor shall personally provide you with the necessary guidance to accomplish this task.

Activities to be Completed up until your First Week…

1. Do you have an OHSU ID badge?
    a. If yes, Mr. Bjerke will help you renew it with specific access to the Radiation Medicine department.
    b. If no, you will need to fill out a background check form and fax it to 503-346-0237 (Attention Ryan Bjerke) or hand it to Mr. Bjerke in person
    c. In addition, you shall complete the following web-based training, if you have not already done so: "Respect at the University" and "HIPPA". Please print out two copies of each certificate and hand them to Mr. Bjerke. You will also need to bring your Driver's License and any other form of picture ID such as a Passport or student ID
        i. Please follow this link https://bigbrain.ohsu.edu/
        ii. Click on "Register" on the "New to Big Brain" tab
        iii. Create a user name and password
        iv. Click on "New OHSU Employee- employee ID and/or Network account not yet assigned"
2. Begin reading literature included in this handbook, as well as any background literature assigned by your advisor
3. Discuss stipend possibilities with your advisor if you are in need of financial support; if you plan to receive financial support from the department, have your mentor confer with Ms. Tracy Browning about the required background check
4. Ask your advisor if you will need EPIC, library, or VA access; if yes, speak to Mr. Ryan Bjerke
5. Ask your mentor if an IRB application has been completed, submitted and/or approved for your project, if applicable
6. Plan with your advisor the time you will spend in clinic

Your Project is not Considered Complete until you have…

1. Prepared a manuscript for submission to a reputable journal that serves Radiation Oncology
2. Presented your project at ASCO, ASTRO, the American Radium Society, the Rubenstein Research Retreat, the OHSU Student Research Forum, or another gathering approved by both your mentor/advisor and Dr. Charles Thomas

Types of Available Projects

The main focus of the Student Clinical Research Program is to engage students in research early in their academic careers and introduce them to a field of radiation oncology. It is expected that students will assist advisors/mentors with an ongoing or new project that are part of the advisors'/mentors' research, not a student directed/initiated project. There is no expectation that the student will be doing "original research of their own design." Each available project shall achieve the following:

1. Provide the student with a good introduction to the purpose of the project, including background literature to read, an orientation to the project, an introduction to the research team, and an understanding of how the student's work fits into the larger project

2. Enable the student to be engaged over time in a variety of tasks with growing responsibility and difficulty as he/she develops skills and knowledge
3. Facilitate opportunities for the student to meet with the entire research group or other team members to learn about the broader scope and goals of the project (if such a group exists)
4. Include regularly scheduled times for the student to meet with his/her advisor/mentor to discuss progress, tasks, next steps, etc. and receive feedback
5. Introduce the student to radiation oncology and the research methods used.

Schedule of Weekly Educational Activities

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7		Hepatobiliary Tumor Board 7:30 AM – 8:30 AM HRC 11th Floor	Esophageal Cancer Conference 7 AM HRC 11th Floor* GU Tumor Board 7 AM – 8 AM HRC 14th Floor Pancreaticobiliary & Esophageal Care 7:30 AM – 8:30 AM HRC 11th Floor Peds Tumor Board 8 AM – 9 AM DCH 10th Floor Leukemia Lymphoma Tumor Board 8 AM – 9 AM HRC 14th Floor	GI Tumor Board 7 AM – 8 AM HRC 14th Floor Pediatric Neuro-Oncology Tumor Board 7 AM – 8 AM Breast Tumor Boards 8:30 AM – 9:30 AM HRC 14th Floor	Adult CNS Tumor Board 7 AM – 8 AM HRC 14th Floor
8					
9			Chart Rounds 9 AM – 10 AM KPV 4153		
10			Resident Lectures 10 AM – 11 AM KPV 4153		
11	VA General Tumor Board 11:30 AM – 12:30 PM		Bi-Weekly Melanoma Tumor Board 11:30 AM – 12:30 PM HRC 14th Floor		

Time	Monday	Tuesday	Wednesday	Thursday	Friday
12			Sarcoma Tumor Board 12:30 PM – 1:30 PM HRC 14th Floor Pediatric Neuro-oncology Planning Conference 12:30 PM – 1:30 PM One/Month	OHSU Lung Conference 12 PM – 1 PM CHH 7th Floor Conference Room	
1	VA Lung Tumor Board 1 PM – 2 PM VA Research Bldg			Spine Tumor Boards 3rd Thursday 4 PM – 5:30 PM KPV4153	GYN Tumor Board 1 PM – 2 PM
2					
3					
4	OHUS ENT Tumor Board 4 PM – 5 PM 3 out of 4 weeks HRC 14th Floor				
5	OHSU Thyroid Tumor Board 4 PM – 5 PM One/Month HRC 14th Floor			Journal Club 4th Thursday 5 PM – 7 PM KPV4153 M&M 1-2 times /year (Journal Club slot)	

* In addition to regularly scheduled activities, special conferences and educational activities will be available. Check your email daily for announcements and look for posted fliers.
* The Esophageal Cancer Conference will be held on the first, third, and fifth Wednesdays in 2011.

Frequently Asked Questions

1. Where do I park?
    a. If you would like to park on campus, you have to purchase a daily parking permit from Public Safety. Otherwise, use public transportation.
2. When do I wear my ID badge?
    a. At all times when you are on campus.
3. Where is my "office space?"
    a. The department of Radiation Medicine is in Kohler Pavilion (KPV) on the 4th floor.
    b. Your mentor/advisor will let you know where your office space will be.
4. I do not have a key to my office space or the door to my office space is locked.
    a. Make sure your badge is visibly displayed
    b. Let either Mr. Ryan Bjerke or Mrs. Tracey Browning know that you are working with a certain mentor/advisor and that you need access to your assigned office space.
5. How do I use the phones?
    a. For calls at OHSU dial the last five digits.
    b. For local calls dial 9, then the number with area code.
6. How do I make copies?
    a. There are two copy machines on KPV4.
    b. There is a copy machine in the OHSU BICC library.
7. I cannot log on to my computer, or my computer doesn't work, or anything with the word computer….
    a. Let your mentor/advisor know. Your mentor will call Mr. Dan Tupper at 503-418-3247 and he will fix it.
8. How do I get a hold of…?
    a. First, check the enclosed Departmental contact sheets, and then call the OHSU operator at 503-494-8311.
9. I need medical records. What do I do?
    a. Let your mentor/advisor know. Your mentor/advisor will call Dan Tupper or Dianna Ramirez with the list of records required either by patient ID or by selection criteria. They will then work with you to determine where the records are located and the best way to access the information you need.
10. I am unsure about what to do about…?
    a. Ask your mentor/advisor for clarification immediately.
11. I need office supplies.
    a. Let your mentor/advisor know. Ask Ryan Bjerke
12. What is the appropriate dress code?
    a. Business casual is appropriate, especially if you are going to see patients.
13. Before the research term begins, what must students have on file?
    a. See page 4 of this handbook
14. Can I take charts home to work on them?
    a. When dealing with patient data, full confidentiality as required by HIPPA

regulations will be followed; no patient records or data are to leave the building.

15. I've never done a poster or PowerPoint presentation before. What do I do?
    a. Your mentor/advisor can give you PowerPoint templates so you can fill in the blanks.
16. My mentor/advisor asked me to submit an IRB (Human Subjects compliance), what do I do?
    a. Ask Barbara Stedman to help with IRB-forms.
    b. Register with the OHSU eIRB-system.
    c. Work with your mentor/advisor on the scientific part of the IRB protocol.
17. What do I do when in doubt?
    a. First: Ask your mentor/advisor
    b. Second: Ask Mr. Ryan Bjerke or Mrs. Tracey Browning.

Exit Presentation

The exit presentation is an opportunity for you to provide an overview of your research project to the department. In preparing your presentation, start with the Methods and Results. Run this draft by your mentor/advisor and research partner. Once you have that done that, figure out how to Introduce the subject and what one can Conclude from your work. The introduction should always include a clear statement regarding the Questions or Hypotheses your work addresses.

10-15 minute oral presentation discussing your research project

Topics to be addressed in your presentation:

1. What information do others need to know to understand your project?
2. What question did you experiment(s) try to answer?
3. Overall, why is such a question or project important?
4. What method(s) did you use to answer the question?
5. What were the results? Were they replicated?
6. What conclusions can one draw from the results of your experiment?
7. How does the project relate to you and your future education/career plans?
8. Where do you expect/hope the project will go after your summer experience?

5 minutes Questions and Answer

Audience members will ask for clarification sometimes, so be ready to answer questions about what you did and how you did it.
Alternatively, you may get a question about context.

1. Why is your work important?
2. Where will it go next?

Be prepared to answer such questions.

Important Tips on Presenting

Come prepared. Remember the saying, “practice makes perfect”.

1. Your presentation should be prepared with Microsoft PowerPoint software.
2. It is recommended that your presentation be complete at least one week prior to the date of delivery to allow time to review and practice.
3. Your presentation should be emailed to your mentor/advisor at least 48 hours prior to the presentation.
4. When arriving to the presentation site, arrive early and dress professionally.
5. Know your audience. The audience will include clinicians and physicist quite knowledgeable of the selected topic (and may in fact have personally participated in research in that particular field) and others who have limited knowledge. The presentation should be of interest to all.
6. Keep slices simple – and explain with words where necessary. There is a “six line” rule for slides – more lines make for cluttered slides.

7. Slides and other audiovisual material are used as an aid to reinforce, clarify, and enhance the spoken word. Include only critical information.
8. Do not read directly from your slides. It is more effective to elaborate verbally on what is written on the slides.
9. Laser pointers should not be overused. Their purpose is to point out a specific item in otherwise busy slides. It is ok to not use a pointer during the entire presentation.
10. Talk to *your audience*! It improves every presentation if you make eye contact with your audience. Or, if that is rather intimidating, you can "fool" your audience into thinking you are talking to them by having the computer screen placed in between you and the audience. (Then you can look at your slides on the computer screen).
11. Never turn your back to the audience.
12. If you cannot remember something, do not try to hide it. The audience can see through that tactic, usually, and may not appreciate it. Remember that the audience is here to help you through your summer experience and optimize your learning.
13. Use of abbreviations: After you define an abbreviation, you may continue using that abbreviation throughout the remainder of the presentation. Rest assured that your audience will clue in and be able to follow.
14. Arouse curiosity of the audience by identifying unexpected events/findings, suggesting provocative ideas.

Preparation is everything!

A Brief Strategy for Writing up Research Results

Get Organized: Lists, Outlines, Notecards, etc. Before starting to write the paper, take the time to think about and develop a list of points to be made in the paper. As you progress, use whichever strategy works for you to begin to order and to organize those points and ideas into sections.

A. Decide to Write a Paper
Make a conscious commitment to start and complete the paper. Nothing succeeds like persistence and resolve.

B. Confer with your Mentor/Advisor
Prior to commencing writing, make sure you are launching in an appropriate direction. You and your mentor should come to agreement on the hypothesis, the data analysis, and the basic interpretations of your study. Your mentor should also be able to make a reasonable appraisal of the study and recommend a suitable target journal. Identifying a target journal early in the process allows you to format the paper in accordance with the particular guidelines of that journal as you write.

C. Create a Timetable
It is commonplace that large jobs should be divided into smaller steps with provisional completion dates. Some psychologists recommend conditioned response strategies (defined workplace, timers) to help bring concerted effort to the defined subtask and to keep you from the temptation (and disillusionment) of viewing the project as one monumental and arduous whole. Here is an example of a timetable:

Session 1: Make notes on the literature, outline template papers, set provisional date for completion.
Session 2: Devise an outline and title for your paper
Session 3: Create a rough first draft
Session 4: Write revision one
Session 5: Write revision two
Session 6: Write third revision, prepare tables and graphs, then give to coauthors
Session 7: Incorporate suggestions from coauthors into the text
Session 8: Prepare all figures and abstract
Session 9: Proof all changes, check all numbers and units, and review the final product with mentor
Session 10: Read one last time and send out

D. Balanced Review of the Primary Research Literature
Perform an in-depth balanced review of the primary research literature relevant to your study prior to designing and carrying out the experiments. This review will help you learn what is known about the topic you are investigating and may let you avoid unnecessarily repeating work done by others. This literature will form the basis of your Introduction and Discussion. Training in on-line searches is available through the library. Do your search early enough to take advantage of the Interlibrary Loan System, if need be.

E. Write the Introduction
Once your hypothesis has been refined for testing, you will draft the Introduction to your paper. Periodically you will bring the Introduction for critique by your mentor/advisor.

F. Design and Conduct the Experiment
Keep careful notes on procedures used during the experiment. You should write the Materials and Methods section upon completion of the experiment.

G. Analyze and Interpret the Results
Once the data are collected, you must analyze and interpret the results. Analysis will include data summaries (e.g., calculating means and variances) and statistical tests to verify conclusions. Most scientists lay out their Tables and Figures upon completion of the data analysis before writing the Results section. Write the Table and Figure legends. It is good practice to note the one or two key results that each Table or Figure conveys and use this information as a basis for writing the Results section. Sequence and number the Tables and Figures in the order which best enables the reader to reach your conclusions.

H. Write the Results Section
Remember that the Results section has both text and illustrative materials (Tables and Figures). Use the text component to guide the reader through your key results, i.e., those results which answer the question(s) you investigated. Each Table and Figure must be referenced in the text portion of the results, and you must tell the reader what the key result(s) is that each Table or Figure conveys.

I. Write the Discussion
Interpretation of your results includes discussing how your results modify and fit in with what you previously understood about the problem. Review the literature again at this time. After completing the experiments you will have much greater insight into the subject, and by going through some of the literature again, information that seemed trivial before, or was overlooked, may tie something together and therefore prove very important to your own interpretation. Be sure to cite the works that you refer to.

J. Write the Abstract and Title
The Abstract is always the last section written because it is a concise summary of the entire paper and should include a clear statement of your aims, a brief description of the methods, the key findings, and your interpretation of the key results. The Title will probably be written earlier, but is often modified once the final form of the paper is clearly known.

K. Self-revise Your Paper
Most authors revise their papers at least 2-3 times before giving it out for peer review. Go back over your paper now and read it carefully; read it aloud. Does it say what you wanted it to say? Do any ideas, experiments, or interpretations need to be moved around within the text to enhance the logical flow of your arguments? Can you shorten long sentences to clarify them? Can you change passive verbs to active forms? Do the Tables and Figures have sufficient information to stand alone outside the context of the paper? Use your dictionary to

correct spelling and your spell checker to catch typographic errors.

L. Peer Review
Have you mentor/advisor and/or knowledgeable colleagues critique your paper. Use their comments to revise your paper yet again.

M. Prepare the Final Draft
Carefully proof-read your final draft to make sure it is as well done as possible. Double-check that you have properly cited all your sources both in the text and in the Literature Cited or References. Check the formatting one last time keeping in mind that different journals have different formatting criteria.

A Detailed Strategy for Writing a Scientific Manuscript

Introduction

Medical science consists to a large degree of discussion and exchange of experience and observations. These may occur via direct dialog among scientists, presentations at conferences, and by means of scientific manuscripts in peer-reviewed journals. Only 50% of abstracts presented at scientific meetings are published in peer-reviewed journals. This is surprising, given that publication of manuscripts is used as a measure of academic success by investigators, their colleagues, their department chair, and those who fund their studies. The purpose of this write-up is to provide a cure for "writer's block," and thus enhance a successful scientific career. The audience for this write-up is the junior academician who needs guidance on how to write a manuscript. It is important to recognize that there are many ways of tackling manuscripts, and that this approach is merely one straightforward method. Although the envisioned manuscript is the research report, these same principles apply, *mutatis mutandis*, to review articles, brief reports, editorials, and case reports.

Step 1: Read the Guide for Authors

Most journals have a Guide for Authors that is printed at least once yearly and is available online. Prior to preparing your manuscript, download and carefully read the Guide for Authors of the journal where you intend to submit your manuscript. There will be detailed information about the interest and scope of the journal, specific information about manuscript types, and detailed instructions on formatting your manuscript. Editors and reviewers notice when authors have not even bothered to read the Guide for Authors or flagrantly disregard instructions on manuscript preparation, style, and formatting.

Step 2: Write the Materials and Methods

The Materials and Methods is the most critical part of the manuscript. It should describe what, *exactly*, you did in the study. Typically there is a handy document that already describes the materials and methods: the study protocol. Therefore, an easy and logical place to start is to cut and paste the study protocol into your Materials and Methods.

The Materials and Methods should typically consist of fewer than 1,000 words. The materials and methods should describe the study in sufficient detail so that a skilled investigator in the field could replicate the study. If the study uses previously published methodology, appropriate reference should be supplied. Often the material and methods will use methodology that has been previously used. In this case, it is acceptable to adapt verbatim previously published material by the same author [of course, it is never acceptable to copy text by another author without appropriate reference and the use of quotation marks if the text is copied verbatim].

If your study involves human subjects, always start with a statement about Institutional Review Board approval and informed consent. If your study involves animal subjects, always start with a statement about approval from the appropriate review board. Following these,

describe your study population in explicit detail. Typically this can be found in the study protocol. If the population is divided into multiple groups, these should be defined. It is easier to read a study if treatment groups are given clear names (e.g., the pre-extraction group vs. the post-extraction group) than simply given letters (group A vs. group B). If there is a random assignment of treatments, the randomization process should be defined. After defining treatment groups, describe how the study was conducted in each group. Typically the description follows a temporal sequence, describing each step in order. Be certain to include all of the measurements that will be reported in the results. Any measurements that were taken to ensure the safety of subjects should also be reported.

After describing the treatments, describe the data analysis plan. This includes how the data were analyzed, including the statistical treatment of the data. *Consult a statistician to make certain that the statistical analysis is appropriate, and that it is accurately described in the manuscript.* Start with a description of the power analysis that was performed (if any). That should be followed by a description of the statistical analysis of the primary endpoint, followed by a description of how secondary endpoints (if any) were analyzed. Complex or unusual analysis approaches should be explained in sufficient detail to permit a skilled statistician to reproduce your results from your data.

Avoid non-standard abbreviations. Unusual abbreviations make manuscripts very difficult to read. If you avoid introducing novel abbreviations in your Materials and Methods, then you are unlikely to introduce them elsewhere. Lastly, science is not a passive process conducted by automatons, but rather a personal adventure of exploration and discovery. It is appropriate to share the humanity of your journey in your manuscript with occasional use of the first person when describing what you did. First person narrative, in limited doses, also makes the manuscript more lively and engaging.

Step 3: Describe your results

The results are the second most important part of your manuscript. Now that you have described what you did (the Materials and Methods), you should next describe what you found. Your scientific peers care about what you did, and what you found. The organization of the results should be parallel to the organization of the methods. Start by describing your population: how many subjects, how many protocol failures, the demographics of the individual groups, etc. Then describe the outcome of your primary variable. That is followed by describing the outcome of your secondary variable. Do not interpret the results – that is the purpose of the discussion.

Typically investigators initially prepare the tables and graphs from their study, and then write their results as a tour of the graphs and tables. That is an efficient way to proceed. The importance of visual presentation of the results cannot be overstated. In virtually every analysis there is a way of presenting the results that is graphically compelling. Conversely, if there is no graphical means of presenting the results, then it is unlikely that the results are of any significance.

Assemble your results in a manner that is understandable at first sight; if you cannot explain it to your mother, then you do not understand what you did. Figures and tables need to be self-

explanatory. The reader should not be forced to go back and forth between the text and the table or figure to interpret it. Do not expect readers to pick up trends in large tables. Trends should always be displayed graphically. There is no "right" number of tables or figures. Too few figures may not show enough of the results to fully communicate the findings. Too many figures may obscure the important results. However, if you have no figures, then you probably do not have an interesting result.

Graph ALL your data whenever possible. There is a tendency for investigators to graph means and standard errors (if showing dispersion of the data) or standard errors (if comparing the means). However, often it is possible to actually display all of the data, not just the mean and the error bars. If there is a way to show all of your data, do it.

Use brief but descriptive legends, and define each abbreviation in each table/figure. Clearly annotate differences in the figures. Provide a column of *p*-values for comparisons, and list the actual value instead of merely "*p*=NS." Let the reader decide if differences are important or if "trends" really exist.

As you write your results, it is appropriate to include in your text the important elements of each table and figure. It is obviously redundant to list 10 demographic variables in a table, and then repeat these numbers in the text. However, if a few are interesting, state the interesting numbers in the text.

Step 4: Discuss your findings

The discussion is where you place your findings in the broader scientific or clinical context. Many authors write lengthy discussions, considering their results from every possible angle, followed by a mini review of the literature. Although some editors may like this approach, an extensive discussion is considered a waste of time by others. What is important are the Materials and Methods and the Results. What the author thinks about it is less interesting.

The discussion should consist of about 1,000 words or less. Before writing the discussion, determine which topics are important. Start with a brief description of the main findings (maximum three sentences) to give the reader a quick orientation. Subsequently, defend your model and explain the rationale for your study methodology. For example, this is a good place to justify your dosages, your protocol, your inclusion and exclusion criteria, and why you chose a specific data analysis approach.

The next step is to place your key findings into scientific and clinical context. Typically this should be no more than a few paragraphs. This is where you would present what other investigators have observed, and why your results either confirm or refute prior observations. This is also the place to present statistical vs. clinical significance. At the end of this section, discuss the impact of your results on clinical practice or patient outcome.

Following this, review the limitations of your study. No study is perfect. What are the pitfalls of your methodology, your study population, your study power, or the presence of confounding and uncontrolled variables?

Finish your discussion with realistic conclusions, preferably in one or two sentences. Understate your conclusions, as overblown or speculative conclusions will draw the ire of reviewers and letters to the editor from annoyed readers. Finally, end with a sentence or two about "next steps" to continue this line of research.

There are several pitfalls to avoid when writing your discussion. Do not claim to be first. That only invites angry letters from others who believe their results should have primacy. Do not ramble. Do not review the literature, other than review what is necessary to place your results into context and properly acknowledge key previous efforts in the field.

Step 5: Write the introduction

The introduction should explain why you did the study, and why anyone should care about the findings (the "so what?" question). The introduction should be no more than a double spaced typed page. First, describe the basic clinical or scientific question of interest. Describe what is unknown about the question. Then, state the population in which you plan to study this question and the key measurements required to answering the question. Conclude your introduction with a clear statement of your primary hypothesis, followed by your secondary hypotheses, if any.

The introduction needs to be written concisely and has to immediately attract the reader. If the introduction does not instill any enthusiasm in your study, it is unlikely that a journal will consider publication. The importance of stating a clear hypothesis or study aim at the end of the introduction cannot be over emphasized, as that is one of the core points of the entire manuscript. *Of course, even though you state the hypothesis late with this writing strategy, the hypothesis needs to be defined before the study*.

Step 6: References

The references demonstrate that you understand how your findings relate to earlier reports. You can safely assume that your reviewers will be the authors of the papers you reference. Do not cite papers if you have only read the abstract, because reviewers can tell if you have misinterpreted their work. Format your references as required by the journal. Sloppy references suggest that your study was also performed in a sloppy manner. Carefully read the guide to authors for the journal you plan to submit to, as this ensures that the manuscript including sections and references are properly formatted. Endnote® or WinWord® allow these functions with little effort and should always be used.

Step 7: Write the abstract

Only after the manuscript is complete should you write the abstract. Again, consult the Guide for Authors to make certain that your abstract is properly formatted. Typically, structured abstracts for all research reports consist of background, methods, results, and conclusions. Be certain to stay within the word limit.

Preparation of the abstract should be straightforward. All components appear in the body of the manuscript. As succinctly as possible, present the background (one sentence), the key components of the methodology, and the key results. Since many online readers can only obtain your abstract, be certain to include enough information that your manuscript results are useful to them. That includes presentation of key numeric results (both mean and variance).

Step 8: Create the title page

Title pages are becoming increasingly complex, as editors strive to comply with the multiple requirements for disclosure of funding, conflicts of interest, open access requirements for several funding agencies, and other challenges. Be certain that the title page contains all of the information required by the journal. One of the main components of the title page is the list of authors. Authorship rewards a scientist for his or her work, but also incurs significant responsibility for the integrity of the data, the data analysis, and the interpretation of the data in the manuscript. Any dilution of academic credit from unearned authorship is unacceptable.

There are many arguments put forward to justify unearned authorship, including "I was around at the time of the study," "It is my topic," "I suggested the study," "The paper will not be published without my name on the author list," "As your department chair, I am the one who made it possible for you to do this study," and "I need authorship for my promotion." The most egregiously abusive practice is the department chair who demands authorship because "I am the one who made it possible for you to do this study." Fortunately, changing standards of academic integrity now mean that the hundreds of unearned authorships on the curriculum vitae of some department chairs have become a source of academic shame rather than academic pride for both the chair and the institution.

There is also an inverse problem, where authors do not wish to see their names included, lest their involvement impairs the chance of publication. This may be the case with papers from the pharmaceutical or device industry, in which scientists who have analyzed the data, and perhaps written the paper, are not acknowledged because they are employed by the study sponsor. This is also dishonest. Authors are those who make intellectual contributions to the work. If there is a conflict of interest, it needs to be disclosed. A conflict of interest, including employment by the study sponsor, does not preclude the requirement that the authorship list accurately reflect the individuals who contributed to the manuscript. Because of the political nature of authorship disputes, experienced colleagues and mentors/advisors must vigorously defend junior authors from transparent violations of authorship requirements.

Step 9: Screen for the Rapid Rejection Criteria

The "Rapid Rejection Criteria" are mistakes that typically result in immediate rejection. The Rapid Rejection Criteria are:

1. The question being asked is not interesting
2. The question being asked has been adequately answered already
3. The question being asked has not been previously asked, but the answer is obvious from what is known in the field
4. The hypothesis is wrong (usually reflecting inadequate preparation)

5. The methodology cannot possibly address the hypothesis
6. The study is obviously underpowered
7. The manuscript does not answer the hypothesis
8. The manuscript contradicts itself
9. The conclusion is not supported by the data.

Although they may not be specifically enumerated, journal editors and reviewers typically have a mental list of Rapid Rejection Criteria that they use to quickly dismiss troubled manuscripts.

Similar to the Rapid Rejection Criteria is the "Worth the Space" question: is the information communicated in the manuscript worth the effort to read the paper? A paper that violates the "worth the space" rule suggests that the authors are excessively enamored of their own work.

If you are not fluent in English, it is absolutely essential that you have an editor who is fluent in scientific English read your paper before submission, assuming your mentor/advisor is not fluent in English either. Remember, if a reviewer struggles to read your paper, the annoyance of struggling to parse poorly written English will likely reduce the reviewer's enthusiasm for the manuscript. Lastly, always employ an electronic spell-check as one of the final steps. Spelling errors are a sign of sloppiness, and a sloppy manuscript implies sloppy research.

Step 10: Rewrite your manuscript

Now that you have written your manuscript, *rewrite it*. Be your harshest critic. Read the manuscript aloud to yourself and listen for any abrupt jumps in the logical flow, any unsupported statements. Read each sentence word for word. Did you leave out the word "not" in the sentence "these results do support the use of technique X"? Would it be clearer to change the name of "Group B" to "Group pre-extraction"? Is there an unnecessary figure? Paragraph? Word? Rip into your paper as viciously as you can, and fix every little detail you can find. Once you have parsed your paper to the most succinct possible text, it is ready to share with your coauthors.

Step 11: Circulate your manuscript

All authors are responsible for the content of the manuscript. Now that you have an initial draft of the paper, circulate it to all of your coauthors (typically with all tables and figures included in a single electronic document) to collect their criticisms and obtain their approval for submission. The co-authors should confirm receiving a readable manuscript, and provide constructive criticism promptly. *The tougher the critique, the better the co-author! If a co-author simply says "everything is OK" they have not read the paper. A coauthor who cannot be bothered to contribute more than "everything is OK" has not taken the intellectual ownership of the material required of coauthors. If they cannot be bothered to critique the papers, remove them from the authorship list.*

It is often useful to also have an interested senior scientist in your institution review the paper and offer editorial suggestions. Every paper, regardless of the skill and experience of the author, benefits from the editorial suggestions of another reader. It is recommended that you asked peers from outside your discipline to read manuscripts before submission to improve the readability of the text.

This is also a good time to "test drive" your manuscript with an audience. Presenting your results in a division, department, institutional, or regional conference is an excellent way to obtain feedback from many observers. Methods or results that they find confusing will likely be confusing to your reviewers as well.

Prepare yourself for a massive revision once you have obtained feedback from all your co-authors and colleagues. If your co-authors have done their job, nearly every sentence will need attention, as will the figures, tables, and logical flow of the paper. That is OK! If your co-authors tear the paper apart before you submit it, the result will be a better paper. If the co-authors do not tear it apart, it is likely that the reviewers will, and the result will be a rejection.

Even the most carefully prepared manuscript may require two or three rounds of review between the first author (with the assistance of the senior author) and the co-authors. A final review should be performed by the first and/or the corresponding author(s) before submission.

2008 International Committee of Medical Journal Editors Statement on Authorship and Contributorship Requirements (verbatim)

Authorship

Authorship credit should be based on:

1. Substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data
2. Drafting the article or revising it critically for important intellectual content
3. Final approval of the version to be published.

Authors should meet conditions 1, 2, and 3.

Acquisition of funding, collection of data, or general supervision of the research group alone does not constitute authorship.

All persons designated as authors should qualify for authorship, and all those who qualify should be listed.

Each author should have participated sufficiently in the work to take public responsibility for appropriate portions of the content. Acquisition of funding, collection of data, or general supervision of the research group, does not justify authorship. This indicates no automatic authorship for technicians, students, coordinators, or chairmen; an active contribution is always required.

If you write a culminating manuscript on your summer research, and your efforts are justified, you will indisputably retain first authorship on the manuscript.

Contributorship

Contributors should be listed in Acknowledgments

All contributors who do not meet the criteria for authorship should be listed in an acknowledgments section. Examples of those who might be acknowledged include a person who provided purely technical help, writing assistance, or a department chairperson who provided only general support.

Financial and material support should also be acknowledged.

Groups of persons who have contributed materially to the paper but whose contributions do not justify authorship may be listed under such headings as “clinical investigators” or “participating investigators,” and their function or contribution should be described – for example, “served as scientific advisors,” “critically reviewed the study proposal,” “collected data,” or “provided and

cared for study patients." Because readers may infer their endorsement of the data and conclusions, these persons must give written permission to be acknowledged.

Guarantor(s)
Some journals now also request that one or more authors, referred to as "guarantors," be identified as the persons who take responsibility for the integrity of the work as a whole, from inception to published article, and publish that information.

The research group should jointly make decisions about contributors/authors before submitting the manuscript for publication. The corresponding author/guarantor should be prepared to explain the presence and order of these individuals.

Manuscript Checklist

1. Spell check has been performed.
2. Text is left justified.
3. The numbers in the Abstract are consistent with the numbers in the Results.
4. The Results report of the measurements described in the Materials and Methods.
5. Read the manuscript aloud to yourself. Does everything read smoothly? Is it easy to understand? Does something sound odd in terms of language, presentation, facts, or context?
6. The manuscript addresses the "So what?" question? (Why should anyone care about this paper?)
7. Limitations are discussed at the end of the discussion.
8. The study answers the question posed in the introduction.
9. The manuscript is consistent (e.g., the abstract, introduction, results, discussion, tables, and figures are internally consistent).
10. The conclusions are supported by the data?
11. The conclusion in the abstract is the same as the conclusion in the discussion.

The Structure, Format, Content, and Style of a Journal Style Scientific Paper

Please remember to look at specific instructions to authors for whichever journal or meeting to which you are planning on submitting prior to beginning to write the paper. Formatting instructions, word limits, and reference format may vary and cause confusion and wasted time for new authors.

Why a Scientific Format?

The scientific format may seem confusing for the beginning science writer due to its rigid structure which is so different from writing in the humanities. One reason for using this format is that it is a means of efficiently communicating scientific findings to the broad community of scientists in a uniform manner. Another reason, perhaps more important than the first, is that this format allows the paper to be read at several different levels. For example, many people skim Titles to find out what information is available on a subject. Others may read only titles and Abstracts. Those wanting to go deeper may look at the Tables and Figures in the Results, and so on. The take home point here is that the scientific format helps to insure that at whatever level a person reads your paper (beyond title skimming), they will likely get the key results and conclusions.

The Sections of the Paper

Most journal-style scientific papers are subdivided into the following sections: Title, Authors and Affiliation, Abstract, Introduction, Methods, Results, Discussion, Acknowledgments, and Literature Cited, which parallel the experimental process. This is the system we will use. This website describes the style, content, and format associated with each section.

The sections appear in a journal style paper in the following prescribed order:

Experimental process	**Section of Paper**
What did I do in a nutshell?	Abstract
What is the problem?	Introduction
How did I solve the problem?	Materials and Methods
What did I find out?	Results
What does it mean?	Discussion
Who helped me out?	Acknowledgments (optional)
Whose work did I refer to?	Literature Cited
Extra Information	Appendices (optional)

How Exactly Do I Write a Scientific Paper?

*Adapted with permission from a text developed by the Applied Ecology Research Group at the University of Canberra Australia, and prepared with the aid of "*How to Write and Publish a Scientific Paper*" by Robert Day (ISI Press, Philadelphia, 1979).*

A scientific paper is a written report describing original research results whose format has been defined by centuries of developing tradition, editorial practice, scientific ethics and the interplay with printing and publishing services. The result of this process is that virtually every scientific paper has a title, abstract, introduction, materials and methods, results and discussion.

It should, however, be noted that most publications have rules about a paper's format: some divide papers into these or some of these sections, others do not, and the order may be different in different publications. So be prepared to revise your paper in to a publication's format when you are ready to submit.

One general point to remember is the need to avoid jargon and acronyms as much as possible. A second is the fact that some journal like papers to be written in the active voice - i.e. "we carried out a test..." rather than "test was carried out to..." — but that this is n always the case.

A. Title

A title should be the fewest possible words that accurately describe the content of the paper. Omit all waste words such as "A study of...", "Investigations of ...", "Observations on ...", etc. Indexing and abstracting services depend on the accuracy of the title, extracting from it keywords useful in cross-referencing and computer searching.

An improperly titled paper may never reach the audience for which it was intended, so be specific. If the study is of a particular specie or chemical, name it in the title. If the study has been limited to a particular region or system, and the inferences it contains are similarly limited, then name the region or system in the title.

B. Keyword List

The keyword list provides the opportunity to add keywords, used by the indexing and abstracting services, in addition to those already present in the title. Judicious use of keywords may increase the ease with which interested parties can locate your article.

C. Abstract

A well-prepared abstract enables the reader to identify the basic content of a document quickly and accurately, to determine its relevance to their interests, and thus to decide whether to read the document in its entirety. The abstract concisely states the principal objectives and scope of the investigation where these are not obvious from the title. More important, it concisely summarizes

the results and principal conclusions. Do not include details of the methods used unless the study is methodological, i.e. primarily concerned with methods.

The abstract must be concise; most journals specify a length, typically not exceeding 250 words. If you can convey the essential details of the paper in 100 words, do not use 200. Do not repeat information contained in the title. The abstract, together with the title, must be self-contained as it is published separately from the paper in abstracting services such as Biological Abstracts or Current Contents. Omit all references to the literature and to tables or figures, and omit obscure abbreviations and acronyms even though the may be defined in main body of the paper.

D. Introduction

The introduction begins by introducing the reader to the pertinent literature. A common mistake is to introduce authors and their area of study in general terms without mention of their major findings. For example: "Parmenter (1976) and Chessman (1978) studied the diet of Chelodina longicollis at various latitudes and Legler (1978) and Chessman (1983) conducted a similar study on Chelodina expansa" compares poorly with: "Within the confines of carnivory, Chelodina expansa is a selective and specialized predator feeding upon highly motile prey such as decapod crustaceans, aquatic bugs and small fish (Legler, 1978; Chessman, 1984), whereas C. longicollis is reported to have a diverse and opportunistic diet (Parmenter, 1976; Chessman, 1984)". The latter is a far more informative lead-in to the literature, but more importantly it will enable the reader to clearly place the current work in the context of what is already known.

Try to introduce references so they do not interfere with the flow of your argument: first write the text without references so that it reads smoothly, then add in the references at the end of sentences or phrases so they do not interrupt your flow. Note that not all journals use author's names in references some use numbers in the text with a list of citations at the end of the article. Check the publication's style when you are ready to submit your paper.

An important function of the introduction is to establish the significance of your current work: Why was there a need to conduct the study? Having introduced the pertinent literature and demonstrated the need for the current study, you should state clearly the scope and objectives.

Avoid a list of points or bullets; use prose.

The introduction can finish with the statement of objectives or, as some people prefer, with a brief statement of the principal findings. Either way, the reader must have an idea of where the paper is heading to follow the development of the evidence.

E. Materials and Methods

The main purpose of the "Materials and Methods" is to provide enough detail for a competent worker to repeat your study and reproduce the results. The scientific method requires that your results be reproducible, and you must provide a basis for repetition of the study by others.

Equipment and materials available off the shelf should be described exactly (e.g. Licor

underwater quantum sensor, Model LI 192SB) and sources of materials should be given if there is variation in quality among supplies. Modifications to equipment or equipment constructed specifically for the study should be carefully described in detail. The method used to prepare reagents, fixatives, and stain should be stated exactly, though often reference to standard recipes in other works will suffice.

The usual order of presentation of methods is chronological. However, related methods may need to be described together and strict chronological order cannot always be followed. If your methods are new (i.e. unpublished), you must provide all the detail required to repeat them. However, if a method has been previously published, only the name of the method and a literature reference need be given.

Be precise in describing measurements and include errors of measurement. Ordinary statistical methods should be used without comment; advanced or unusual methods may require a literature citation. Show your materials and methods section to a colleague. Ask if they would have difficulty in repeating your study.

F. Results

In the results section you present your findings: display items (figures and tables) are central in this section. Present the data, digested and condensed, with important trends extracted and described. Because the results comprise the new knowledge that you are contributing to the world, it is important that your findings be clearly and simply stated.

The results should be short and sweet. Do not say, “It is clearly evident from Fig. 1 that bird species richness increased with habitat complexity”. Say instead “Bird species richness increased with habitat complexity (Fig. 1)”.

However, don’t be too concise. Readers cannot be expected to extract important trends from the data unaided. Few will bother. Combine the use of text, tables and figures to condense data and highlight trends. In doing so be sure to refer to the guidelines for preparing tables and figures below.

G. Discussion

In the discussion you should discuss what principles have been established or reinforced; hat generalizations can be drawn; how your findings compare to the findings of others or to expectations based on previous work; and whether there any theoretical/practical implications of your work.

When you address these questions, it is crucial that your discussion rests firmly on the evidence presented in the results section. Refer briefly to your results to support your discussion statements. Do not extend your conclusions beyond those that are directly supported by your results.

A brief paragraph of speculation about what your results may mean in a general sense is usually

acceptable, but should not form the bulk of the discussion. Be sure to address the objectives of the study in the discussion and to discuss the significance of the results. Don't leave the reader thinking "So what?". End the discussion with a short summary or conclusion regarding the significance of the work.

H. References

Whenever you draw upon information contained in another paper, you must acknowledge the source. All references to the literature must be followed immediately by an indication of the source of the information that is referenced, e.g. "A drop in dissolved oxygen under similar conditions has been demonstrated before (Norris, l986)."

If two authors are involved, include both surnames in this reference. However if more authors are involved, you may use 'et al., an abbreviation of Latin meaning "and others". In general you should not use the abbreviation in the full reference at the end of the article although some journals permit this. If two more articles written by the same author in the same year are cited, most journals ask you to add suffixes "a", "b" etc in both the text and the reference list.

If you include in your report phrases, sentences or paragraphs repeated verbatim from the literature, it is not sufficient to simply cite the source. You must include the material in quotes and you must give the number of the page from which the quote was lifted. For example: "Day (l979: 3l) reports a result where '33.3% of the mice used in this experiment were cured by the test drug; 33.3% of the test population were unaffected by the drug and remained in a moribund condition; the third mouse got away'".

A list of references ordered alphabetically by author's surname, or by number, depending on the publication, must be provided at the end of your paper. The reference list should contain all references cited in the text but no more. Include with each reference details of the author, year of publication, title of article, name of journal or book and place of publication of books, volume and page numbers.

Formats vary from journal to journal, so when you are preparing a scientific paper for an assignment, choose a journal in your field of interest and follow its format for the reference list. Be consistent in the use of journal abbreviations.

I. Appendices

Appendices contain information in greater detail than can be presented in the main body of the paper, but which may be of interest to a few people working specifically in your field. Only appendices referred to in the text should be included.

J. Formatting conventions

Most publications have guidelines about submission and manuscript preparation, for online or mailed submissions. Most journals require the manuscript to be typed with double spacing throughout and reasonable margins. Make sure you read the guide to authors before submitting

your paper so that you can present your paper in the right format for that publication (refer to submission of paper article in this series).

Finally — and perhaps most importantly — ALWAYS read the journal's guide to authors before submitting a paper, and ALWAYS provide an informative cover letter to your submission.

K. Constructing tables

DO include a caption and column headings that contain enough information for the reader to understand the table without reference t the text. The caption should be at the head of the table.

DO organize the table so that like elements read down, not across.

DO present the data in a table or in the text, but never present the same data in both forms.

DO choose units of measurement so as to avoid the use of an excessive number of digits.

DO NOT include tables that are not referred to in the text.

DO NOT be tempted to "dress up" your report by presenting data in the form of tables or figures that could easily be replaced by a sentence or two of text. Whenever a table or columns within a table can be readily put into words, do it.

DO NOT include columns of data that contain the same value throughout. If the value is important to the table include it in the caption or as a footnote to the table.

DO NOT use vertical lines to separate columns unless absolutely necessary.

L. When constructing figures

DO include a legend describing the figure. It should be succinct yet provide sufficient information for the reader to interpret the figure without reference to the text. The legend should be below the figure.

DO provide each axis with a brief but informative title (including units of measurement)

DO NOT include figures that are not referred to in the text, usually in the text of the results section.

DO NOT be tempted to "dress up" your report by presenting data in the form of figures that could easily be replaced by a sentence or two of text.

DO NOT fill the entire A4 page with the graph leaving little room for axis numeration, axis titles and the caption. The entire figure should lie within reasonable margins (say 3 cm margin on the left side, 2 cm margins on the top, bottom and right side of the page).

DO NOT extend the axes very far beyond the range of the data. For example, if the data range between 0 and 78, the axis should extend no further than a value of 80.

DO NOT use color, unless absolutely necessary. It is very expensive, and the costs are usually passed on to the author. Color in figures may look good in an assignment or thesis, but it means redrawing in preparation for publication.

How to Read a Paper
Statistics for the non-statistician I: Different types of Data need Different Statistical Tests *BMJ* 1997; 315:364-366.

A. Introduction

As medicine leans increasingly on mathematics no clinician can afford to leave the statistical aspects of a paper to the "experts." If you are numerate, try the "Basic Statistics for Clinicians" series in the Canadian Medical Association Journal,[1-4] or a more mainstream statistical textbook.[5] If, on the other hand, you find statistics impossibly difficult, this article and the next in this series give a checklist of preliminary questions to help you appraise the statistical validity of a paper.

B. Have the authors set the scene correctly?

Have they determined whether their groups are comparable, and, if necessary, adjusted for baseline differences?

Most comparative clinical trials include either a table or a paragraph in the text showing the baseline characteristics of the groups being studied. Such a table should show that the intervention and control groups are similar in terms of age and sex distribution and key prognostic variables (such as the average size of a cancerous lump). Important differences in these characteristics, even if due to chance, can pose a challenge to your interpretation of results. In this situation, adjustments can be made to allow for these differences and hence strengthen the argument.[6]

C. Summary points

1. In assessing the choice of statistical tests in a paper, first consider whether groups were analyzed for their comparability at baseline.
2. Does the test chosen reflect the type of data analyzed (parametric or non-parametric, paired or unpaired)?
3. Has a two tailed test been performed whenever the effect of an intervention could conceivably be a negative one?
4. Have the data been analyzed according to the original study protocol?
5. If obscure tests have been used, do the authors justify their choice and provide a reference?

What sort of data have they got, and have they used appropriate statistical tests? Numbers are often used to label the properties of things. We can assign a number to represent our height, weight, and so on. For properties like these, the measurements can be treated as actual numbers. We can, for example, calculate the average weight and height of a group of people by averaging the measurements. But consider an example in which we use numbers to label the property "city of origin," where 1=London, 2=Manchester, 3=Birmingham, and so on. We could still calculate the average of these numbers for a particular sample of cases, but we would be completely unable

to interpret the result. The same would apply if we labeled the property "liking for x" with 1=not at all, 2=a bit, and 3=a lot. Again, we could calculate the "average liking," but the numerical result would be uninterruptable unless we knew that the difference between "not at all" and "a bit" was exactly the same as the difference between "a bit" and "a lot."

All statistical tests are either parametric (that is, they assume that the data were sampled from a particular form of distribution, such as a normal distribution) or non-parametric (they make no such assumption). In general, parametric tests are more powerful than non-parametric ones and so should be used if possible. Non-parametric tests look at the rank order of the values (which one is the smallest, which one comes next, and so on) and ignore the absolute differences between them.

As you might imagine, statistical significance is more difficult to show with non-parametric tests, and this tempts researchers to use statistics such as the r value inappropriately. Not only is the r value (parametric) easier to calculate than its non- parametric equivalent but it is also much more likely to give (apparently) significant results. Unfortunately, it will give a spurious estimate of the significance of the result, unless the data are appropriate to the test being used. More examples of parametric tests and their non-parametric equivalents are given in table 1).

Table 1: Some commonly used statistical tests.

Parametric test	Example of equivalent non-parametric test	Purpose of test	Example
Two sample (unpaired) *t* test	Mann-Whitney U test	Compares two independent samples drawn from the same population	To compare girls' heights with boys' heights
One sample (paired) *t* test	Wilcoxon matched pairs test	Compares two sets of observations on a single sample	To compare weight of infants before and after a feed
One way analysis of variance (*F* test) using total sum of squares	Kruskall-Wallis analysis of variance by ranks	Effectively, a generalisation of the paired *t* or Wilcoxon matched pairs test where three or more sets of observations are made on a single sample	To determine whether plasma glucose level is higher one hour, two hours, or three hours after a meal
Two way analysis of variance	Two way analysis of variance by ranks	As above, but tests the influence (and interaction) of two different covariates	In the above example, to determine if the results differ in male and female subjects
χ^2 test	Fisher's exact test	Tests the null hypothesis that the distribution of a discontinuous variable is the same in two (or more) independent samples	To assess whether acceptance into medical school is more likely if the applicant was born in Britain
Product moment correlation coefficient (Pearson's *r*)	Spearman's rank correlation coefficient (r183 σ)	Assesses the strength of the straight line association between two continuous variables.	To assess whether and to what extent plasma HbA1 concentration is related to plasma triglyceride concentration in diabetic patients
Regression by least squares method	Non-parametric regression (various tests)	Describes the numerical relation between two quantitative variables, allowing one value to be predicted from the other	To see how peak expiratory flow rate varies with height
Multiple regression by least squares method	Non-parametric regression (various tests)	Describes the numerical relation between a dependent variable and several predictor variables (covariates)	To determine whether and to what extent a person's age, body fat, and sodium intake determine their blood pressure

Another consideration is the shape of the distribution from which the data were sampled. When I was at school, my class plotted the amount of pocket money received against the number of children receiving that amount. The results formed a histogram the same shape as figure 2—a "normal" distribution. (The term "normal" refers to the shape of the graph and is used because many biological phenomena show this pattern of distribution). Some biological variables such as body weight show "skew normal" distribution, as shown in figure 3. (Figure 3) shows a negative skew, whereas body weight would be positively skewed. The average adult male body weight is 70 kg, and people exist who weigh 140 kg, but nobody weighs less than nothing, so the graph cannot possibly be symmetrical.

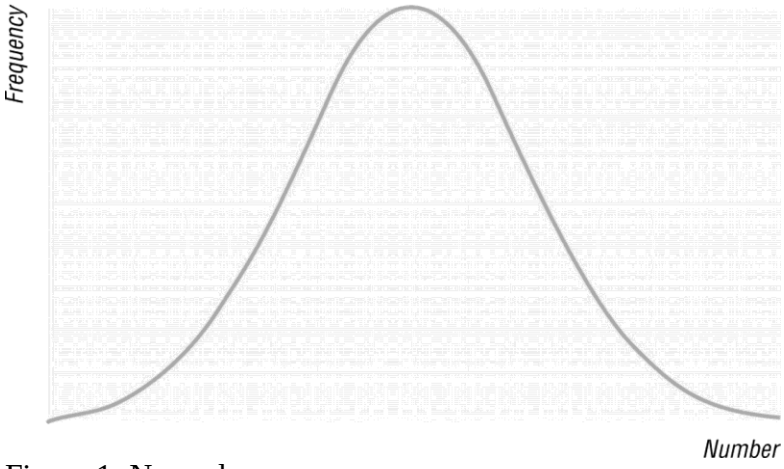

Figure 1: Normal curve.

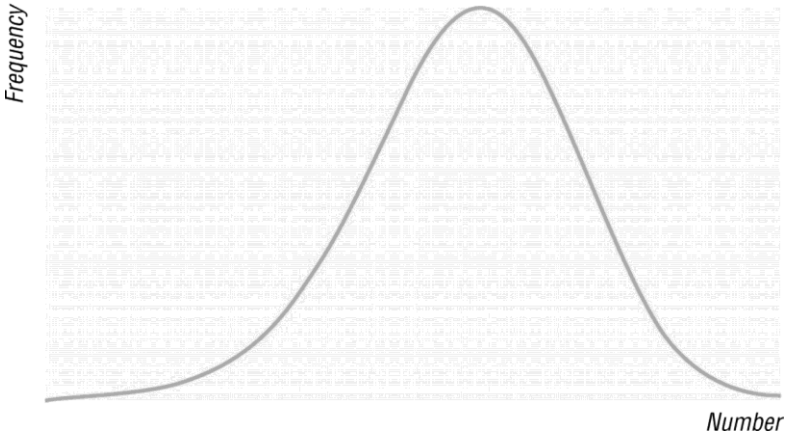

Figure 2: Skewed curve.

Non-normal (skewed) data can sometimes be transformed to give a graph of normal shape by performing some mathematical transformation (such as using the variable's logarithm, square root, or reciprocal). Some data, however, cannot be transformed into a smooth pattern. For a very readable discussion of the normal distribution see chapter 7 of Martin Bland's Introduction to Medical Statistics.[5] Deciding whether data are normally distributed is not an academic exercise, since it will determine what type of statistical tests to use. For example, linear regression will give misleading results unless the points on the scatter graph form a particular distribution about the regression line—that is, the residuals (the perpendicular distance from each point to the line)

should themselves be normally distributed. Transforming data to achieve a normal distribution (if this is indeed achievable) is not cheating: it simply ensures that data values are given appropriate emphasis in assessing the overall effect. Using tests based on the normal distribution to analyze non-normally distributed data, however, is definitely cheating.

If the authors have used obscure statistical tests, why have they done so and have they referenced them?

The number of possible statistical tests sometimes seems infinite. In fact, most statisticians could survive with a formulary of about a dozen. The rest should generally be reserved for special indications. If the paper you are reading seems to describe a standard set of data, which have been collected in a standard way, but the test used has an unpronounceable name and is not listed in a basic statistics textbook, you should smell a rat. The authors should, in such circumstances, state why they have used this test, and give a reference (with page numbers) for a definitive description of it. Are the data analyzed according to the original protocol?

If you play coin toss with someone, no matter how far you fall behind, there will come a time when you are one ahead. Most people would agree that to stop the game then would not be a fair way to play. So it is with research. If you make it inevitable that you will (eventually) get an apparently positive result you will also make it inevitable that you will be misleading yourself about the justice of your case.[7] (Terminating an intervention trial prematurely for ethical reasons when subjects in one arm are faring particularly badly is a different matter and is discussed elsewhere.[7]) Raking over your data for "interesting results" (retrospective subgroup analysis) can lead to false conclusions.[8] In an early study on the use of aspirin in preventing stroke, the results showed a significant effect in both sexes combined, and a retrospective subgroup analysis seemed to show that the effect was confined to men.[9] This conclusion led to aspirin being withheld from women for many years, until the results of other studies[10] showed that this subgroup effect was spurious.

This and other examples are included in Oxman and Guyatt's, "A consumer's guide to subgroup analysis," which reproduces a useful checklist for deciding whether apparent subgroup differences are real.[11]

D. Paired data, tails, and outliers

Were paired tests performed on paired data?
Students often find it difficult to decide whether to use a paired or unpaired statistical test to analyze their data. There is no great mystery about this. If you measure something twice on each subject—for example, blood pressure measured when the subject is lying and when standing—you will probably be interested not just in the average difference of lying versus standing blood pressure in the entire sample, but in how much each individual's blood pressure changes with position. In this situation, you have what is called "paired" data, because each measurement beforehand is paired with a measurement afterwards.

In this example, it is using the same person on both occasions, which makes the pairings, but there are other possibilities (for example, any two measurements of bed occupancy made of the same

hospital ward). In these situations, it is likely that the two sets of values will be significantly correlated (for example, my blood pressure next week is likely to be closer to my own blood pressure last week than to the blood pressure of a randomly selected adult last week). In other words, we would expect two randomly selected paired values to be closer to each other than two randomly selected unpaired values. Unless we allow for this, by carrying out the appropriate paired sample tests, we can end up with a biased estimate of the significance of our results.

Was a two tailed test performed whenever the effect of an intervention could conceivably be a negative one? The term "tail" refers to the extremes of the distribution—the areas at the outer edges of the bell in figure 2. Let's say that the graph represents the diastolic blood pressures of a group of people of which a random sample are about to be put on a low sodium diet. If a low sodium diet has a significant lowering effect on blood pressure, subsequent blood pressure measurements on these subjects would be more likely to lie within the left tail of the graph. Hence we would analyze the data with statistical tests designed to show whether unusually low readings in this patient sample were likely to have arisen by chance.

But on what grounds may we assume that a low sodium diet could only conceivably put blood pressure down, but could never do the reverse, put it up? Even if there are valid physiological reasons in this particular example, it is certainly not good science always to assume that you know the direction of the effect which your intervention will have. A new drug intended to relieve nausea might actually exacerbate it, or an educational leaflet intended to reduce anxiety might increase it. Hence, your statistical analysis should, in general, test the hypothesis that either high or low values in your dataset have arisen by chance. In the language of the statisticians, this means you need a two tailed test, unless you have very convincing evidence that the difference can only be in one direction. Were "outliers" analyzed with both common sense and appropriate statistical adjustments? Unexpected results may reflect idiosyncrasies in the subject (for example, unusual metabolism), errors in measurement (faulty equipment), errors in interpretation (misreading a meter reading), or errors in calculation (misplaced decimal points). Only the first of these is a "real" result, which deserves to be included in the analysis. A result, which is many orders of magnitude away from the others, is less likely to be genuine, but it may be so. A few years ago, while doing a research project, I measured several different hormones in about 30 subjects. One subject's growth hormone levels came back about 100 times higher than everyone else's. I assumed this was a transcription error, so I moved the decimal point two places to the left. Some weeks later, I met the technician who had analyzed the specimens and he asked, "Whatever happened to that chap with acromegaly?" Statistically correcting for outliers (for example, to modify their effect on the overall result) requires sophisticated analysis and is covered elsewhere.[6]

E. Acknowledgements

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How to read a paper
Statistics for the non-statistician. II: "Significant" relations and their pitfalls
***BMJ* 1997;315:422-425**

A. Introduction
This article continues the checklist of questions that will help you to appraise the statistical validity of a paper. The first of this pair of articles was published last week.[1]

B. Correlation, regression, and causation
Has correlation been distinguished from regression, and has the correlation coefficient (r-value) been calculated and interpreted correctly?For many non-statisticians, the terms "correlation" and "regression" are synonymous, and refer vaguely to a mental image of a scatter graph with dots sprinkled messily along a diagonal line sprouting from the intercept of the axes. You would be right in assuming that if two things are not correlated, it will be meaningless to attempt a regression. But regression and correlation are both precise statistical terms, which serve quite different functions.[1]
The r-value (Pearson's product-moment correlation coefficient) is among the most overused statistical instrument. Strictly speaking, the r value is not valid unless the following criteria are fulfilled:

C. Summary points
An association between two variables is likely to be causal if it is strong, consistent, specific, plausible, follows a logical time sequence, and shows a dose-response gradient. A p-value of <0.05 means that this result would have arisen by chance on less than one occasion in 20.

The confidence interval around a result in a clinical trial indicates the limits within which the "real" difference between the treatments is likely to lie, and hence the strength of the inference that can be drawn from the result.

A statistically significant result may not be clinically significant. The results of intervention trials should be expressed in terms of the likely benefit an individual could expect (for example, the absolute risk reduction).

- The data (or, more accurately, the population from which the data are drawn) should be normally distributed. If they are not, non-itemmetric tests of correlation should be used instead.[1]
- The two datasets should be independent (one should not automatically vary with the other). If they are not, a paired *t* test or other paired test should be used.
- Only a single pair of measurements should be made on each subject. If repeated measurements are made, analysis of variance should be used instead.[2]
- Every *r* value should be accompanied by a P value, which expresses how likely an association of this strength would be to have arisen by chance, or a confidence interval, which expresses the range within which the "true" *r* value is likely to lie.

Remember, too, that even if the r value is appropriate for a set of data, it does not tell you whether the relation, however strong, is causal (see below).

The term "regression" refers to a mathematical equation that allows one variable (the target variable) to be predicted from another (the independent variable). Regression, then, implies a direction of influence, although—as the next section will argue—it does not prove causality. In the case of multiple regression, a far more complex mathematical equation (which, thankfully, usually remains the secret of the computer that calculated it) allows the target variable to be predicted from two or more independent variables (often known as covariables).

The simplest regression equation, which you may remember from your school days, is y=abs, where y is the dependent variable (plotted on the vertical axis), x is the independent variable (plotted on the horizontal axis), and a is the y intercept. Not many biological variables can be predicted with such a simple equation. The weight of a group of people, for example, varies with their height, but not in a linear way. I am twice as tall as my son and three times his weight, but although I am four times as tall as my newborn nephew I am much more than six times his weight. Weight, in fact, probably varies more closely with the square of someone's height than with height itself (so a quadratic rather than a linear regression would probably be more appropriate).

Of course, even when the height-weight data fed into a computer are sufficient for it to calculate the regression equation that best predicts a person's weight from their height, your predictions would still be pretty poor since weight and height are not all that closely correlated. There are other things that influence weight in addition to height, and we could, to illustrate the principle of multiple regression, enter data on age, sex, daily calorie intake, and physical activity into the computer and ask it how much each of these covariables contributes to the overall equation (or model).

The elementary principles described here, particularly the criteria for the r value given above, should help you to spot whether correlation and regression are being used correctly in the paper you are reading. A more detailed discussion on the subject can be found elsewhere.[2-3] Have assumptions been made about the nature and direction of causality? Remember the ecological fallacy: just because a town has a large number of unemployed people and a very high crime rate, it does not necessarily follow that the unemployed are committing the crimes. In other words, the presence of an association between A and B tells you nothing at all about either the presence or the direction of causality. To show that A has caused B (rather than B causing A, or A and B both being caused by C), you need more than a correlation coefficient. The box gives some criteria, originally developed by Sir Austin Bradford Hill, which should be met before assuming causality.[4]

D. Tests for causation[4]

1. Is there evidence from true experiments in humans?
2. Is the association strong?
3. Is the association consistent from study to study?
4. Is the temporal relation appropriate (did the postulated cause precede the postulated

effect)?
5. Is there a dose-response gradient (does more of the postulated effect follow more of the postulated cause)?
6. Does the association make epidemiological sense?
7. Does the association make biological sense?
8. Is the association specific?
9. Is the association analogous to a previously proved causal association?

E. Probability and confidence

Have "P values" been calculated and interpreted appropriately?

One of the first values a student of statistics learns to calculate is the P value—that is, the probability that any particular outcome would have arisen by chance. Standard scientific practice, which is entirely arbitrary, usually deems a P value of less than 1 in 20 (expressed as $P<0.05$, and equivalent to a betting odds of 20 to 1) as "statistically significant" and a P value of less than 1 in 100 ($P<0.01$) as "statistically highly significant. By definition, then, one chance association in 20 (this must be around one major published result per journal issue) will seem to be significant when it is not, and one in 100 will seem highly significant when it is really what my children call a "fluke." Hence, if you must analyze multiple outcomes from your data set, you need to make a correction to try to allow for this (usually achieved by the Bonferroni method[5-6]). A result in the statistically significant range ($P<0.05$ or $P<0.01$, depending on what is chosen as the cut off) suggests that the authors should reject the null hypothesis (the hypothesis that there is no real difference between two groups). But a P value in the non-significant range tells you that either there is no difference between the groups or that there were too few subjects to demonstrate such a difference if it existed—but it does not tell you which.

The P value has a further limitation. Guyatt and colleagues, in the first article of their "Basic Statistics for Clinicians" series on hypothesis testing using P values, conclude: "Why use a single cut off point [for statistical significance] when the choice of such point is arbitrary? Why make the question of whether a treatment is effective a dichotomy (a yes-no decision) when it would be more appropriate to view it as a continuum?"[7] For a better assessment of the strength of evidence, we need confidence intervals.

Have confidence intervals been calculated, and do the authors' conclusions reflect them?

A confidence interval, which a good statistician can calculate on the result of just about any statistical test (the t test, the r value, the absolute risk reduction, the number needed to treat, and the sensitivity, specificity, and other key features of a diagnostic test), allows you to estimate for both "positive" trials (those that show a statistically significant difference between two arms of the trial) and "negative" ones (those that seem to show no difference), whether the strength of the evidence is strong or weak, and whether the study is definitive (obviates the need for further similar studies). The calculation and interpretation of confidence intervals have been covered elsewhere.[8] If you repeated the same clinical trial hundreds of times, you would not get exactly the same result each time. But, on average, you would establish a particular level of difference (or lack of difference) between the two arms of the trial. In 90% of the trials the difference

between two arms would lie within certain broad limits, and in 95% of the trials it would lie between certain, even broader, limits.

Now, if (as is usually the case) you conducted only one trial, how do you know how close the result is to the "real" difference between the groups? The answer is you don't. But by calculating, say, the 95% confidence interval around your result, you will be able to say that there is a 95% chance that the "real" difference lies between these two limits. The sentence to look for in a paper should read something like: "In a trial of the treatment of heart failure, 33% of the patients randomized to ACE inhibitors died, whereas 38% of those randomized to hydralazine and nitrates died. The point estimate of the difference between the groups [the best single estimate of the benefit in lives saved from the use of an ACE inhibitor] is 5%. The 95% confidence interval around this difference is -1.2% to 12%."

More likely, the results would be expressed in the following shorthand: "The ACE inhibitor group had a 5% (95% CI -1.2% to 12%) higher survival." In this particular example, the 95% confidence interval overlaps zero difference and, if we were expressing the result as a dichotomy (that is, is the hypothesis "proved" or "disproved"?) we would classify it as a negative trial. Yet as Guyatt and colleagues argue, there probably is a real difference, and it probably lies closer to 5% than either - 1.2% or 12%. A more useful conclusion from these results is that "all else being equal, an ACE inhibitor is the appropriate choice for patients with heart failure, but the strength of that inference is weak."[9]

Note that the larger the trial (or the larger the pooled results of several trials), the narrower the confidence interval—and, therefore, the more likely the result is to be definitive. In interpreting "negative" trials, one important thing you need to know is whether a much larger trial would be likely to show a significant benefit. To determine this, look at the upper 95% confidence limit of the result. There is only one chance in 40 (that is, a 2½% chance, since the other 2½% of extreme results will lie below the lower 95% confidence limit) that the real result will be this much or more. Now ask yourself, "Would this level of difference be clinically important?" If not, you can classify the trial as not only negative but also definitive. If, on the other hand, the upper 95% confidence limit represented a clinically important level of difference between the groups, the trial may be negative but it is also non-definitive.

The use of confidence intervals is still relatively uncommon in medical papers. In one survey of 100 articles from three of North America's top journals (the New England Journal of Medicine, Annals of Internal Medicine, and the Canadian Medical Association Journal), only 43 reported any confidence intervals, whereas 66 gave a p-value.[7] An even smaller proportion of articles interpret their confidence intervals correctly. You should check carefully in the discussion section to see whether the authors have correctly concluded not only whether and to what extent their trial supported their hypothesis, but also whether any further studies need to be done.

F. The bottom line

Have the authors expressed the effects of an intervention in terms of the likely benefit or harm which an individual patient can expect?

It is all very well to say that a particular intervention produces a "statistically significant difference" in outcome, but if I were being asked to take a new medicine I would want to know how much better my chances would be (in terms of any particular outcome) than they would be if I didn't take it. Four simple calculations (if you can add, subtract, multiply, and divide you will be able to follow this section) will enable you to answer this question objectively and in a way that means something to the non-statistician. These calculations are the relative risk reduction, the absolute risk reduction, the number needed to treat, and the odds ratio.

To illustrate these concepts, and to persuade you that you need to know about them, consider a survey which Tom Fahey and his colleagues conducted recently.[10] They wrote to 182 board members of district health authorities in England (all of whom would be in some way responsible for making important health service decisions), asking them which of four different rehabilitation programs for heart attack victims they would prefer to fund:

Program A reduced the rate of deaths by 20%

Program B produced an absolute reduction in deaths of 3%

Program C increased patients' survival rate from 84% to 87%

Program D meant that 31 people needed to enter the program to avoid one death.

Let us continue with the example shown in Table 1), which Fahey and colleagues reproduced from a study by Salim Yusuf and colleagues.[11] I have expressed the figures as a two by two table giving details of which treatment the patients received in their randomized trial and whether they were dead or alive 10 years later.

Simple mathematics tells you that patients receiving medical treatment have a chance of 404/1324=0.305 or 30.5% of being dead at 10 years. Let us call this risk x.

Patients randomized to coronary artery bypass grafting have a chance of 350/1325=0.264 or 26.4% of being dead at 10 years. Let us call this risk y.

The relative risk of death—that is, the risk in surgically treated patients compared with medically treated controls—is y/x or 0.264/0.305=0.87 (87%).

The relative risk reduction—that is, the amount by which the risk of death is reduced by the surgery—is 100%-87% (1-y/x)=13%.

The absolute risk reduction (or risk difference)—that is, the absolute amount by which surgical treatment reduces the risk of death at 10 years—is 30.5%-26.4%=4.1% (0.041).

The number needed to treat—how many patients need coronary artery bypass grafting in order to prevent, on average, one death after 10 years—is the reciprocal of the absolute risk reduction: 1/ARR=1/0.041=24.

Yet another way of expressing the effect of treatment is the odds ratio. Look back at the two by two table and you will see that the "odds" of dying compared with the odds of surviving for patients in the medical treatment group is 404/921=0.44, and for patients in the surgical group is 350/974=0.36. The ratio of these odds will be 0.36/0.44=0.82.

The general formulas for calculating these "bottom line" effects of an intervention, taken from Sackets and colleagues' latest book,[12] are shown in the box. The outcome event can be desirable (cure, for example) or undesirable (an adverse drug reaction). In the latter case, it is semantically preferable to refer to numbers needed to harm and the relative or absolute increase in risk.

Calculating the "bottom line" effects on an intervention			
	Outcome Event		
Group	Yes	No	Total
Control Group	a	b	a+b
Experimental Group	c	d	c+d

Control event rate (CER)=risk of outcome event in control group=a/(a+b)
Experimental event rate (EER)=risk of outcome event in experimental group=c/(c+d)
Relative risk reduction (RRR)=(CER—EER)/CER
Absolute risk reduction (ARR)=CER—EER
Number needed to treat (NNT)=1/ARR=1/(CER—EER)

G. Summary

It is possible to be seriously misled by taking the statistical competence (and/or the intellectual honesty) of authors for granted. Some common errors committed (deliberately or inadvertently) by the authors of papers are given in the final box.

Ten ways to cheat on statistical tests when writing up results

1. Throw all your data into a computer and report as significant any relation where P<0.05
2. If baseline differences between the groups favour the intervention group, remember not to adjust for them
3. Do not test your data to see if they are normally distributed. If you do, you might get stuck with non-item metric tests, which aren't as much fun
4. Ignore all withdrawals (drop outs) and non-responders, so the analysis only concerns subjects who fully complied with treatment
5. Always assume that you can plot one set of data against another and calculate an "*r* value" (Pearson correlation coefficient), and assume that a "significant" *r* value proves causation
6. If outliers (points which lie a long way from the others on your graph) are messing up your calculations, just rub them out. But if outliers are helping your case, even if they seem to be spurious results, leave them in
7. If the confidence intervals of your result overlap zero difference between the groups, leave them out of your report. Better still, mention them briefly in the text but don't draw them in on the graph—and ignore them when drawing your conclusions

8. If the difference between two groups becomes significant four and a half months into a six month trial, stop the trial and start writing up. Alternatively, if at six months the results are "nearly significant," extend the trial for another three weeks
9. If your results prove uninteresting, ask the computer to go back and see if any particular subgroups behaved differently. You might find that your intervention worked after all in Chinese women aged 52-61
10. If analyzing your data the way you plan to does not give the result you wanted, run the figures through a selection of other tests

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Appendix: Finding of Research Misconduct 2011

Notice Number: NOT-OD-11-070

Key Dates: Release Date: April 29, 2011

Issued by: Department of Health and Human Services

Notice is hereby given that the Office of Research Integrity (ORI) has taken final action in the following case:
Vipul Bhrigu, PhD, University of Michigan Medical School: Based on the findings of an investigation by the University of Michigan Medical School (UMMS) and additional analysis conducted by the Office of Research Integrity (ORI) during its oversight review, ORI found that Vipul Bhrigu, PhD, former postdoctoral fellow, Department of Internal Medicine, UMMS, engaged in research misconduct in research funded by National Cancer Institute (NCI), National Institutes of Health (NIH), grant R01 CA098730-05.

Specifically, ORI found that the Respondent knowingly and intentionally tampered with research materials related to five (5) immunoprecipitation/Western blot experiments and switched the labels on four (4) cell culture dishes for cells used in the same type of experiments to cause false results to be reported in the research record. ORI also found that the Respondent tampered with laboratory research materials by adding ethanol to his colleague's cell culture media, with the deliberate intent to effectuate the death of growing cells, which caused false results to be reported in the research record. ORI has concluded that these acts seriously deviated from those that are commonly accepted within the scientific community for proposing, conducting, and/or reporting research.

ORI found that the Respondent's intentional tampering of his colleague's laboratory research constitutes research misconduct as defined by 42 CFR part 93. ORI determined that the Respondent engaged in a pattern of dishonest conduct through the commission of multiple acts of data falsification. ORI also determined that the subterfuge in which he freely engaged for several months constitutes an aggravating factor. The Respondent attempted to mislead the University of Michigan (UM) police by initially denying involvement in the tampering and refusing to accept responsibility for this misconduct. The Respondent eventually made an admission only after the UM police informed him that his actions in the laboratory had been videotaped. This dishonest conduct established the Respondent's lack of present responsibility to be a steward of Federal funds (2 CFR 376 et seq.; 42 CFR 93.408).

The following administrative actions have been implemented for a period of three (3) years, beginning on April 7, 2011:

Dr. Bhrigu is debarred from eligibility for any contracting or subcontracting with any agency of the United States Government and from eligibility for, or involvement in, nonprocurement programs of the United States Government, referred to as ``covered transactions,' pursuant to HHS' Implementation of OMB [[Page 23600]] Guidelines to Agencies on Government-wide Debarment and Suspension (2 CFR 376 et seq.); and

Dr. Bhrigu is prohibited from serving in any advisory capacity to the U.S. Public Health Service (PHS), including but not limited to service on any PHS advisory committee, board, and/or peer review committee, or as a consultant.

Notice Number: NOT-OD-11-071

Key Dates: Release Date: April 29, 2011

Issued by: Department of Health and Human Services

Notice is hereby given that the Office of Research Integrity (ORI) has taken final action in the following case:
Junghee J. Shin, PhD, New York Medical College: Based on the report of an investigation conducted by New York Medical College (NYMC) and additional analysis by the Office of Research Integrity (ORI) in its oversight review, the U.S. Public Health Service (PHS) found that Junghee J. Shin, PhD, former graduate student, NYMC, engaged in research misconduct in research supported by National Institute of Allergy and Infectious Diseases (NIAID), National Institutes of Health (NIH), grants R01 AI048856 and R01 AI043063.
PHS found that the Respondent engaged in research misconduct by falsifying data in Figure 4 of a manuscript submitted to the journal Infection and Immunity (Shin, J.J., Godfrey, H.P., & Cabello, F.C. ``Expression and localization of BmpC in Borrelia burgdorferi after growth under various environmental conditions.' Submitted to Infection and Immunity; hereafter referred to as the ``manuscript') and Figure 5 of a paper published in Infection and Immunity (Shin, J.J. Bryksin, A.V., Godfrey, H.P., & Cabello, F.C. ``Localization of BmpA on the exposed outer membrane of Borrelia burgdorferi by monospecific anti-recombinant BmpA rabbit antibodies.' Infection and Immunity 72(4):2280-2287, April 2004; hereafter referred to as the ``paper.' Retracted in: Infection and Immunity 76(10):4792, October 2008).
Specifically, NYMC and ORI found that:

Dr. Shin falsified microscopic immunofluorescence blank images in Figure 4 of the manuscript (top row, 1st, 2nd, 4th, and 5th panels, and bottom row, 1st panel) and Figure 5 of the paper (top row, 1st and 5th panels, lower 1st panel) by using one blank image from an unknown experiment to falsely represent the preimmunization control conditions (intact cells and methanol fixation) as well as the negative staining of anti-BmpC and anti-FlaB in Figure 4 and anti-FlaB in Figure 5 on intact cells.

Dr. Shin falsified at least one of two images in Figure 4 of the manuscript and Figure 5 of the paper by using different portions of a green-red pair of microscopic immunofluorescence images (1230036.tif and 1230037.tif) because unfixed cells staining positive for BmpA in the top row, 4th panel, of Figure 5 were the same unfixed cells purportedly positive for OspA in the top row, 3rd panel, of Figure 4.

Dr. Shin falsified at least one of two images in Figure 4 of the manuscript and Figure 5 of the paper by using different photo cropping from a single microscopic immunofluorescence image (1230039.tif) to represent fixed cells positive for BmpA and labeled with anti-FlaB in the lower row, 5th panel, of Figure 5 and to also represent fixed

cells positive for BmpC and stained with anti-FlaB in the lower row, 5th panel, of Figure 4.

Dr. Shin has entered into a Voluntary Settlement Agreement in which she has voluntarily agreed, for a period of three (3) years, beginning on April 5, 2011:

> That any institution that submits an application for PHS support for a research project on which the Respondent's participation is proposed or that uses her in any capacity on PHS-supported research, or that submits a report of PHS-funded research in which she is involved, must concurrently submit a plan for supervision of her duties to ORI for approval; the supervisory plan must be designed to ensure the scientific integrity of her research contribution; Respondent agrees that she will not participate in any PHS-supported research until such a supervision plan is submitted to ORI; and
>
> to exclude herself voluntarily from service in any advisory capacity to PHS, including but not limited to service on any PHS advisory committee, board, and/or peer review committee, or as a consultant.