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The DOI for this manuscript is doi: 10.5858/arpa.2019-0490-RA

The final published version of this manuscript will replace the Early Online Release version at the above DOI once it is available.

Conducting a Pathology Research Study, From Start to Finish

A Guide for Residents and Fellows

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• **Context.**—Many pathologists-in-training enter residency or fellowship with either no formal experience in research or with a basic science research background that may not translate well to research in the realm of diagnostic pathology, including surgical pathology, cytopathology, and clinical pathology.

Objective.—To provide a starting point and practical framework for residents or fellows who wish to conduct research in these fields.

Data Sources.—Existing literature and the pooled experience of the authors, all academic pathologists.

Conclusions.—We provide tips and tricks that trainees will find useful when planning and executing pathology research projects. A key component of successful research in diagnostic pathology is active guidance by a skilled faculty mentor, bolstered by enthusiastic, timely work by a highly motivated and dedicated trainee. We hope this advice will improve interactions between trainees and their faculty mentors and enhance the quality of research in diagnostic pathology.

(*Arch Pathol Lab Med*. doi: 10.5858/arpa.2019-0490-RA)

Pathology is a broad field, and pathology residency therefore offers a wide variety of translational research opportunities.¹ Trainees may decide to conduct research projects for a number of reasons. These include sharing original observations and making meaningful contributions to the literature, disseminating new knowledge regarding emerging or diagnostically useful ancillary techniques, learning more about an entity they encounter during residency/fellowship rotations, having the chance to present their research in abstract form at national or international meetings, evaluating whether they would like to make research a component of their eventual career choices, learning the mechanics of performing research in order to better critically evaluate published manuscripts, and/or fulfilling a requirement of their training program.² In one European survey, roughly half of pathology trainees reported they were encouraged to pursue research during residency.³ Regardless of the purpose and focus of the work, there is a series of steps that is more likely to result in successful completion, presentation, and publication of

research projects. To that end, we have composed this guide as a reference for pathology residents and fellows who are undertaking a research project, possibly for the first time.

WHERE DO I START?

Helpful tips to get started in pathology research are listed in Table 1 and discussed in depth in the following sections.

Preparation, Preparation, Preparation

One common pathway toward a research project is a trainee approaching a faculty member (staff pathologist/attending pathologist/potential mentor/guide) and asking to work with them, with the intention of serving as lead author on an abstract (to be presented at a national meeting) and subsequently completing a manuscript. For trainees considering this approach, there are important preparatory steps that will help ensure that the research is interesting, worth pursuing, and accomplishable in the time frame of pathology training.

An initial helpful question to ask yourself is: “What subspecialty within pathology interests me?” While you may already have seized upon a specific research idea (eg, “Does malignancy X label for immunostain Y?”), most trainees—especially early in residency—are not quite at this point. It is certainly helpful to have a general idea (eg, “breast pathology”) and to identify a faculty member who has a track record of successful research with trainees and the time and energy to focus on collaboration/mentoring. Residents or fellows who are senior to you or those who have worked with faculty on research projects may be helpful in guiding you toward these individuals, and a PubMed search may also help you with this step.

Accepted for publication November 11, 2019.

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The authors have no relevant financial interest in the products or companies described in this article.

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Table 1. Where to Start? Top 10 Helpful Tips for Beginning a Research Project

Tips	Notes
1. Identify a faculty mentor	Consider whom you would like to work with; check PubMed to see what your faculty mentor has published (and with whom); ask senior residents if they can identify faculty with a track record of successfully mentoring trainees. Senior faculty may seem the obvious choice, but young, energetic faculty can be great to work with and may have more “bandwidth” to mentor trainees.
2. Try to pick your mentor in the subspecialty you are leaning toward	Although this approach is ideal, it may not always be practical, especially early in residency. For those who are not focused on 1 subspecialty, well-conducted research on any topic will be beneficial.
3. Approach the faculty member whom you wish to be your mentor personally	An informal chat is a must, so both parties can understand the scope of the project, the timeline, and the time commitment required. This is an opportunity to gauge “fit” of personalities as well.
4. Do NOT commit if you are not interested or cannot afford the time commitment	It is best to be honest up-front. The scenario of a trainee working on a project they are not interested in is frustrating for both trainee and mentor.
5. Do not wait until you have a research idea	Ask your mentor for ideas! Many of the best research projects executed by trainees are the product of ideas that originate from experienced faculty. It may take years of experience and expertise to figure out where problem areas lie, to identify fruitful areas of investigation, and to make key observations. This is where your mentor can help you the most!
6. Get institutional review board approval to perform research	Start this process as early as possible. This can take time and can be a limiting factor to getting your research started.
7. Be punctual, courteous, and enthusiastic	Remember, your mentor is constantly evaluating your professional attributes in deciding whether to take you on as a mentee. Leave a good impression—pathology is a small specialty!
8. Move quickly	Once your mentor gives you a set of concrete instructions regarding the project, follow up on them quickly or communicate if you anticipate any delays.
9. Start collecting references	Search PubMed and identify and organize at least a few articles from reputable journals that will be most relevant to your project.
10. Remember: the goal is publication of your research as a full manuscript in a peer-reviewed journal	Presenting a poster or platform, even at a major meeting, is NOT the final step. If that is as far as you want to go, be honest and up-front about this early.

Not all projects are trainee initiated. In fact, some of the best projects in the field of diagnostic pathology originate from ideas that have been brewing in the minds of pathologists with years of experience. Such ideas often take time, wisdom, diagnostic skill, academic interest, subspecialty expertise, and extensive knowledge of the field, which leads to insights regarding fruitful avenues of inquiry. Faculty members interested in involving residents/fellows in research endeavors may approach you with an idea, perhaps based on their experience, a conversation about a disease entity, or an interesting case/series of cases seen at the microscope or in the laboratory. While fruitful collaborations certainly may begin in this manner and the trainee may feel honored to be approached, one must honestly evaluate whether one has the time and energy to undertake the project properly and see it to fruition. Residency is a demanding time in one’s life, and pressure to undertake “extra projects” was listed as a major stressor in a survey of pathology residents.⁴ First-author duties on high-quality research projects can take anywhere from a dozen hours to several months or more to complete, especially if the duties include reviewing a large volume of cases or intensive analysis and scrutiny of data. Hence, it is important to prioritize personally and professionally and then commit to research only if you are confident that it fits within your bandwidth. While the hierarchy of medicine may make it scary to say “no” to your attendings, it will be more detrimental to your reputation to say “yes” and then do less than stellar work on a project.

Finally, residents should double-check any institutional requirements they must complete before being allowed to

do research, such as Collaborative Institutional Training Initiative certification.⁵

Planning Your Project

Once you have decided to conduct research and before beginning the work, it is necessary to meet with your faculty mentor to discuss and understand the details of your project. In these initial encounters, the following issues should be addressed:

Research Design.—This includes the specific hypothesis being addressed, the question(s) being answered, the rationale for the project, an overview of how the research will be undertaken (ie, what authors will do what), and an example of potential findings. If statistical analysis is necessary, you (along with your faculty mentor) should collaborate with a statistician at this point to determine what analyses can and should be performed based on the study design and the research hypothesis and goals. Storage of data should also be discussed (including password protection, backup schedules and location, and proper handling of protected health information).

Trainees should come prepared for these discussions by acquiring some basic background information about the topic (eg, Is this entity common or rare/hard to diagnose? Is the immunohistochemical antibody or assay well studied and commercially available?) and by the end of the session should be sure to understand the key aspects of the work. Try to understand why your faculty mentor has posed their hypothesis and how the study design will address it. Basic background information should be supplemented by a brief review of the existing literature. While studies that replicate

or validate the findings of prior studies absolutely have value, a question that already has been studied extensively may not require repeated study from your group. Do not be afraid to ask questions or express your thoughts. If you do not grasp some portion of the research you are about to undertake, the project may become frustrating. If the proposed project seems unusual or potentially unnecessary, ask for clarity. Most importantly, if the research does not have a clear goal but seems to be “research for the sake of research,” discuss further with your mentor and be prepared to politely decline—your time is valuable!

Note: If the project requires payment to cover physical materials (eg, immunohistochemistry kits and reagents) or time and effort (eg, statistician support), a source of funding will be necessary. Your faculty mentor should cover this; you should not be expected to contribute funds at this point in your career. Potential sources of funding include departmental/institutional grants,⁶ extramural government grants, and grants from private organizations. Such sources of funding should be disclosed when appropriate, along with any potential conflicts of interest that might arise from such monetary support.

Authorship.—For most trainee projects, the resident/fellow is the first (“lead”) author and will do most of the data collection and much, if not all, of the abstract/manuscript drafting. The faculty member with whom you have chosen to work will be the last (“senior”) author and will be responsible for the intellectual “heavy lifting,” ensuring that the results are placed in an appropriate context, as well as project coordination. Based on the study design, other researchers may be “middle” authors and contribute additional efforts to the work, such as statistical analysis or ancillary techniques/data. It is useful to discuss authorship order early in the manuscript planning process.⁷ While the senior author typically decides on the final authorship list, as a trainee, you will want to know who else is working on the project and in what capacity to prevent surprises later. Establishing authorship is of particular importance when collaborating on a project with faculty from multiple departments or institutions. We would stress that although first authorship comes with added prestige, it also brings greater responsibility. You must make every effort to be timely and responsible, and to keep the project on track. Manuscripts abandoned by the initial first author occasionally get assigned to other individuals who might be more motivated to take the project to completion.⁷ All authors should make some form of meaningful contribution to the project, by directly contributing data, labor, and/or expertise. Examples of unacceptable justifications for authorship, such as “I signed out these cases” or “I need authorship for my promotion,” have been previously discussed by Shidham et al,⁸ and the International Committee of Medical Journal Editors⁹ has published recommended criteria for authorship. If any doubts exist or persist about the author order, the identity of all authors, or the role and amount of work expected from each author, these should be clarified as early and precisely as possible, as attempting to tackle such issues reactively rather than proactively can harm both the manuscript and interpersonal relationships.

Institutional Review Board Approval.—Currently, institutional review boards (IRBs) are in place at most institutions. The aim of these bodies is to ensure ethical conduct of research, including human subjects research. Obtaining IRB approval or clearance may be a lengthy

process that is often the first concrete step taken before the initiation of any research project.¹⁰ While your senior author might offer to handle submission of a research protocol to the IRB, some will prefer you to have this experience, which—albeit somewhat tedious—can be extremely valuable if you are considering an academic career. Many pathology research projects are considered “exempt” research with minimal risk to patient safety aside from loss of confidentiality, considering that projects often work with already existing information and do not involve interacting with patients or directly influencing the course of their care. Regardless of who handles the submission process, you must check the IRB status of the work you intend to perform, as most aspects cannot be performed without approval. You should also read the IRB for your project to ensure that you follow its guidelines and do not overstep them (eg, retaining unnecessary identifiable information).

Timeline.—Trainees often want to submit research abstracts to national or international pathology meetings to have the opportunity to present their findings. These meetings establish firm submission deadlines to which researchers must adhere. The timeline should be discussed with your mentor at the beginning of the project, months before any deadline. Having such a deadline can help guide when cases need to be available for review, when data need to be prepared for statistical analysis, and when a first draft of an abstract needs to be provided to the senior author. A generic sample timeline template is provided as Table 2; actual dates and steps can of course vary depending on the project.

Commitment.—While not all abstracts presented at national meetings result in published articles,¹¹ the presumption is that the trainee will follow the project to completion (ie, drafting and submitting a manuscript). Therefore, one should make one’s intentions clear before undertaking the work. While it may seem exciting to simply present a research abstract (particularly if the meeting is in a glamorous location), your faculty mentor will find it unprofessional if you decide not to write a manuscript but fail to disclose this until after the abstract deadline/presentation. Be explicit and up-front about your final goal for the project.

Next Steps.—The next section will summarize your tasks as lead author on the project. Your advisor should help guide you through these next steps following the initial planning meeting(s).

HOW DO I GET MY PROJECT OFF THE GROUND?

Now that you have selected your mentor and project, it’s time to get started. This section highlights tips for actualizing your research project and preparing it for presentation.

Conducting the Research

All research studies have several components that are the purview of the first author. These include data collection, background investigation, and preparatory activities that will facilitate writing the abstract and manuscript.

It is important to always keep in mind that *research is collaborative*. Your faculty mentor has agreed to work on this project with you, and you should keep in touch throughout the process, providing regular and timely updates and asking clarifying questions as necessary. Never just “guess” about an aspect of the work.

Table 2. Sample Timeline Template for Research Project

Activity	Responsible Author	Expected Outcome	Due Date
Discuss and finalize hypothesis and project design	Lead author, statistician, senior author	Have concrete plan for study design and data collection	March 1
Submit IRB proposal	Senior author	Have IRB approval for research	April 1
Identify and pull cases following IRB approval	Lead author	Determine what cases are available for project; reassess feasibility	May 1
Review cases and pick appropriate block for staining from each	Lead author	Obtain data	July 1
Review and verify collected data	Lead author, statistician, senior author	Assure integrity and validity of project data	July 15
Perform staining on cases	Senior author, IHC coauthor	Obtain additional data for project	August 15
Perform statistical analysis	Statistician	Determine statistical relevance of collected data	September 1
Draft abstract	Lead author, senior author (all coauthors to review draft)	Submit suitable abstract to meeting	September 20
Draft manuscript	Lead author, senior author (all coauthors to contribute to draft)	Have manuscript prepared for submission to reputable journal	February 1
Prepare poster/platform for presentation	Lead author, senior author (all coauthors to contribute to draft)	Have poster/platform of abstract to present at meeting	February 20
Revise manuscript and submit to journal	Lead author, senior author	Submit manuscript bolstered by input from meeting	As soon as possible following meeting

Abbreviations: IHC, immunohistochemistry; IRB, institutional review board.

Your responsibilities include the following:

Obtaining Background Information.—Review the existing literature for publications relevant to your topic. Read and summarize as many relevant papers as possible (helpful hint: take notes for future reference), or at an absolute minimum, attempt to read and understand the papers' abstracts. This will give you an idea of what is already known and what knowledge gap your study may help fill. Not sure where to begin? Your faculty mentor is likely acquainted with at least some of this information and can point you toward key existing articles or reliable journal sources. A medical librarian may also be available to assist in your search. As you perform your literature review, using a reference manager (eg, EndNote [Clarivate Analytics, Philadelphia, Pennsylvania], Zotero [Corporation for Digital Scholarship, Vienna, Virginia], Mendeley [Elsevier, Amsterdam, the Netherlands]) or compiling the papers you find in an organized manner will greatly facilitate preparing a manuscript.^{12,13} On the other hand, if your manuscript is very short or has only a few references, manual citation of references may be less cumbersome.

Gathering Data.—This generally involves analyzing and annotating slides (hematoxylin-eosin and/or immunohistochemical stains) or assay results and extracting clinical information from the electronic medical record. It is important to keep information organized in a database manager (such as Microsoft Access [Microsoft Corporation, Redmond, Washington]), a spreadsheet file (such as Microsoft Excel), or a similar format. Spreadsheets serve as a medium for data collection and facilitate statistical analysis.¹⁴ As you will likely return to this spreadsheet many times and a statistician may work from it as well, the data must be clearly labeled. If you use abbreviations and/or colors to highlight certain information, create a legend that can be easily understood by others. Before data collection, it is a good idea to check your spreadsheet format with your

mentor and statistician (if applicable) to ensure that all important elements are being captured and formatted optimally—the experience of having to re-review hundreds of records for a missed data element is not one you wish to have! Store data in a secure location (such as cloud storage or an institutional drive) where authors with appropriate clearance can access it.

Preparing Ancillary Materials.—As you begin to compile various clinical and pathology data points, consider summarizing the information in 1 or a few tables (in a text document file such as Microsoft Word or spreadsheet document file such as Microsoft Excel). In a similar vein, as you and your mentor review cases, make sure to identify key findings and/or excellent representations of your topic, such that you can produce high-quality photographs. Both tables and figures are common components of presentations and manuscripts and may even be inserted into a research abstract. When creating a table or taking a photo, make sure you can link it to specific data or a certain slide.

Thinking About the Results.—Throughout the process of conducting your research, consider what your findings may mean in the context of the background information you encounter and the goals of the project. Be prepared to highlight some of these to the senior author when you meet to discuss the project.

Re-engage Your Faculty Mentor.—At a reasonable (or better yet: previously agreed upon) interval before a research/abstract deadline, forward a summary of background literature, your methods, tables, and figures to the senior author. (Data should not be emailed or transferred via unencrypted flash drive, but should be securely available, as discussed above.) If statistical analysis has been arranged for your study, contact the statistician regarding the data and double-check that analysis can be completed within your timeline. Arrange a meeting to discuss your findings and be prepared to share your thinking as to their

importance. Be prepared for your mentor to provide a constructive critique of your work, including gaps that may need to be filled before proceeding to publication. Finally, agree upon what information will be shared in a research abstract versus left for the future manuscript.

Formulating an Abstract/Poster

If you and your mentor have decided to bypass this phase and proceed directly to a manuscript, please skip this section. Many (if not most) trainees, however, have identified abstract presentation as a preliminary goal.

Items You Can Handle in Advance.—Especially if this is your first encounter with the abstract submission process or if you are submitting to a meeting for the first time, be sure to review the abstract requirements set by the meeting. Unfortunately, at the current time, various meetings have different length and formatting requirements—be prepared! In general, you will have a few hundred words to work with (often expressed as “character number”), which mandates a concise presentation. Abstracts are often split into 4 sections: Background, Methods, Results, and Conclusions. This basic format will carry over into presentations and the manuscript, and you may well have encountered it in manuscripts you reviewed for background information.

Writing the Abstract.—You, as the lead author, should formulate a first draft of the abstract. This version does not need to be perfect but is intended to be a rough draft of your initial thoughts. Reflect on your discussions with your mentor—both at the beginning of the process and after assembling the data—and include all information you think is necessary to convey the context, purpose, activities, and take-home message of your research. In a first draft, it is perfectly fine to go a bit beyond the length limit, as your faculty mentor will assist in further focusing and clarifying the abstract language. If the format allows, a well-chosen photograph and/or a table can convey a lot of information in a relatively short space. After receiving feedback, make necessary revisions (this may take a couple of drafts) and coordinate with your mentor to ensure that the abstract is submitted online before the deadline. It is possible that you and/or your attending may not be free close to that time, so don't wait until the last minute! There may be a fee associated with abstract submission, which may be reimbursable through your department.

If the abstract is not accepted, you can reformat it, potentially add additional data or reframe the argument, and submit it to another meeting. If the abstract is accepted and you will be presenting it, you will most likely compose a poster (caveat: oral presentations/platform talks are another mode of presentation, which is outside the scope of this document).

Preparing a Poster.—(1) “Don't reinvent the wheel”—many in your department have done this before; check with your mentor, residency director, and/or fellow trainees to see if there are existing Microsoft PowerPoint templates that your department/institution uses for poster presentations (this can save you a lot of time and frustration); (2) Carefully discuss the poster layout with your mentor before doing any work—understand clearly what their expectations are, what story you intend to convey, and whether they have a preferred sequence of materials (eg, photos/figures in the center, text on the sides); (3) Typically, the poster is an expanded version of your abstract, and much of the same information will be included. If additional data become available between abstract submission and presentation, it is

important to query your mentor as to whether it adds to your message and should be incorporated; (4) Photographs and tables are valuable in the poster format, as they “tell a story” quickly and may attract meeting attendees to view and discuss your work; as a general rule, you should include concise text regarding background/context and a clear statement and/or representation of your methods and results; (5) No more than a few reasonable conclusions should be presented in the poster—do not exaggerate your findings or overstate their significance; statements such as “our findings suggest that...” are necessary if additional work or analysis will be done after the time of abstract presentation. You can print your poster locally and carry it to the meeting, which is the traditional method but requires traveling with an unwieldy poster tube. Other options are to print a cloth poster (which is more easily portable), upload the file to an online printer who will ship the poster to the meeting, or print the poster on-site at the meeting. All options will cost money, which again may be reimbursable through your department.

Best Preparation for the Next Phase.—Ideally, you should aim to have a written draft of the corresponding manuscript (see below) ready before poster presentation. This will ensure that you are thoroughly knowledgeable about your project and the research topic, and therefore adequately prepared to present. An additional benefit is that you can easily absorb feedback/critiques you receive at the poster presentation for incorporation into your manuscript.

HOW DO I WRITE MY PAPER?

Writing a manuscript can be the most intellectually demanding and difficult part of the entire research process, but it should also be among the most rewarding. Our tips are summarized in Table 3.

Drafting the Manuscript

Ultimately, all your work has led to this point. While all research projects have several potentially valuable outcomes (including interesting findings, groundwork for future studies, and experience gained by the authors), we have anecdotally noted that some academically minded diagnostic pathologists argue that if a research project does not result in a peer-reviewed, published manuscript, then the project was never truly completed. Once again, it is necessary to meet with your mentor before working on the manuscript. They may have suggestions regarding format and journal choice that will impact your approach to writing. As above, reference manager software is very helpful to organize references and format citations as you write the manuscript, organize and reorganize portions of the text, and add or delete information across drafts. While these managers have a price to pay in terms of a learning curve or an actual monetary cost, consider this an up-front investment that can lead to countless hours of future time savings! Another important note worth repeating, that is applicable to all engagement with technology, is to save your work early and often, and create frequent backups.

As you write, strive to be understood. This can be difficult when dealing with complex scientific concepts, but the goal is to present your results clearly and elegantly, not to obfuscate your work, test the publisher's page and/or character limits, or try to sound overly important. Rules for clear manuscript writing from the perspective of a journal editor have been summarized elsewhere.^{8,15} Your job

Table 3. Writing Your Manuscript: Top 10 Helpful Tips

Tips	Notes
1. Do some background reading on your topic	This will help you understand the rationale for your study and show you what has already been done in the field. This also helps with reference citation later in the process.
2. Give your manuscript a structure and format	Open a text document and type in the following headings: Title page, Abstract, Introduction, Materials and Methods, Results, Discussion, Tables, Figures, Figure legends.
3. Introduction	This section briefly explains why you conducted your study. End with a sentence summarizing the aim.
4. Materials and Methods	Explain what you did. How did you collect materials and perform the analysis? Provide details that others would need to replicate your findings. Consider writing this section first.
5. Results	Use your tables and figures as a framework to present your collected data in an orderly, organized fashion. Consider writing this section second.
6. Discussion	This is the space to explain the significance of your findings to the reader. Do NOT repeat the results here, though they can be summarized or referred to in context. End with a brief take-home message.
7. Figures	Take photomicrographs yourself, saving them as TIFF or JPG files. Use only high-quality pictures that illustrate the main points of your paper. Do not embed pictures in your text document.
8. Tables	These may be used to summarize information or to provide side-by-side details and comparisons that would make the main text too cluttered and/or dense. Use table headings.
9. References	Ask your faculty mentor which journal(s) you should consider submitting to and be sure to strictly follow formatting instructions of the one selected. Do not add references that are not pertinent or that you have not read.
10. Above all, be honest	Although this should be obvious, it is worth stressing: do not copy, plagiarize, exaggerate, or overstate. Even if your findings are not earth-shaking, they may be useful—all progress in medicine is incremental. Stick to the truth, and let your results speak for themselves.

should be to engage the reader's intellect, not exhaust it. Along these lines, try to minimize abbreviations, limiting yourself to a few key and well-accepted ones (eg, IHC for immunohistochemistry).

Manuscripts are generally divided into Introduction/Background, Materials & Methods, Results, and Discussion (as opposed to Conclusions, which is the last section in an abstract).¹⁶ Although many journals do not require a formal Conclusion, most authors include a summative paragraph at the end of the Discussion section that serves this purpose. Manuscripts also have abstracts; fortunately, you should be able to use the abstract you submitted for presentation, with some modification.

If you become "stuck" at any point while writing the manuscript, always keep in mind the design of the study and the specific hypothesis that the study has proposed and is investigating. Contextualizing your information, and your thoughts about the information, can help integrate them into the text.

Materials & Methods.—Even though this is the "second section," consider working on it first. It is essentially a factual account of what you did (eg, we identified X cases of entity Y and studied several different aspects of the histomorphology, recorded patient outcomes, and correlated the histomorphology with outcome). This is generally the easiest section to write, with little room for interpretation and few if any references necessary; now that you have something on paper, you're off to a good start. If there are aspects of your paper's Methods, such as statistics or staining protocols, that you cannot adequately describe because they were not part of your contribution, insert a placeholder and then contact the coauthors who can provide both the "write-up" and the understanding of these components.

Results.—Similarly, consider working on this section after finishing Materials & Methods. Again, you are reporting existing findings, which takes some composition but should be a straightforward process. Consider which of your data points are to be grouped together and, if it is helpful, make an outline with headers to ensure that your

findings are labeled correctly. If you have trouble getting started, arrange your data into a few tables (which you may have already composed for the abstract). Also, create a series of clean, appropriately framed and cropped photographs (best in composite/collage form, with appropriate legends) that summarize the story you are trying to tell. From these, it may become easier to describe your findings in text, using the tables and photographs as guideposts. It is unnecessary to simply repeat what is in the tables/figures in text form (eg, if Table 1 lists the 10 patients in your case series along with their clinicopathologic information, the text might simply summarize the highlights). Additionally, tables can provide a more digestible format for a large amount of data than extensive, repetitive text; if composing a portion of the Results text feels monotonous and excessive, consider using a table instead. Interpretation of results belongs in the Discussion section and should not be a component of the Results section.

Introduction/Background.—This section provides context for the entire project, and it is an opportunity to display the information you learned earlier while reviewing the literature. Think of your overall topic as a jigsaw puzzle with a few pieces missing. Existing manuscripts are the available pieces, and in this section of the manuscript, you will describe them and piece together as much as you can. Once the puzzle is described as completely as possible, you can end this section by proposing a hypothesis that serves to examine one of the missing pieces, namely, the knowledge gap that your work will address.

Discussion.—In the final section, you will write about the conclusions and meaning of your work, discussing their significance relative to existing literature and implications for patient care. This is often the most challenging section to write. Be honest about your findings and what they mean—avoid exaggeration. Depending on background literature, you may be able to compare your results with those from other studies. Some theorizing can be done as well, within reason. Even a quick perusal of the medical literature will reveal a variety of methods for constructing an adequate Discussion. If you are having trouble, one factor to consider

is the nature of your findings. For instance, if your work has one main takeaway finding, you might write this section as a “decrecendo,” in which the Discussion begins by stating the importance of the main findings in context, proceeds to discuss any implications of that finding, and then addresses more minor aspects of the work. Conversely, if your research led to several small but related findings, you might write this section as a “crescendo,” where a discussion of the findings builds upon one another to culminate in a take-home message. Crucially, even the best-conducted study has limitations, and it is considered good practice to add a paragraph discussing these, including the reasons for them and why they may or may not affect your ultimate finding(s). The last paragraph of your manuscript can serve as a both a conclusion and as a precursor to what may come next. Just as your project likely builds upon existing findings, your data will now be “existing findings” for future research. You might mention what avenues should next be explored in this research sphere, possibly taking into consideration your newly presented findings. Finally, if you’re not sure whether to add something, don’t—there is no need to ramble!

Although this may seem unusual, consider having a nonpathologist review your manuscript. While the individual may not understand every nuance of your work, if they are able to grasp the overall idea, this is an indication that you have likely done a good job writing a clean, understandable document. Other tips for improving the quality of your manuscript include multiple rounds of revision and rewriting, reading your manuscript aloud, checking for appropriate “flow” without abrupt transitions, and a final check to ensure that all tables, figures, and references have been appropriately cited.⁸

Bringing the Manuscript to Fruition

Once you have completed a draft, save the file in an easily identifiable manner (eg, with your initials, the date, and the word “draft” in the file name). Send it to your mentor, who will review it, make edits and/or suggestions, and likely return it to you for additional work. Do not be offended—this is part of the routine editing process that brings a manuscript to completion. The process of writing, submitting, and revising a manuscript is almost always an iterative one, so keep this in mind to avoid becoming discouraged! The senior author should also coordinate input from other coauthors, to ensure that they too have a chance to review and propose edits to the draft. Always save prior drafts, and rename subsequent draft files in an easily identifiable format with version numbers or dates (eg, include “V1” at the end of the file name of your first draft, then “V3” at the end of the file name for your revision incorporating the suggestions of your mentor [which would have been “V2”]).

The final step is submitting the paper! Journal selection, an important part of the publication process, has been addressed in detail elsewhere.⁸ Important issues to consider in making this decision include the reputation and impact factor of the journal, the degree of fit between your subject matter and the journal’s audience, the circulation and viewership of the journal, the journal’s reputation in terms of fairness of reviews and turnaround time, and the potential for widespread dissemination. Once you and the senior author have decided on a journal, carefully review the Instructions for Authors section on the journal’s Web site. This will detail how to format your submission. Most journals have cover letter requirements and image require-

ments (such as file format and image resolution).¹⁷ Your attending may have template cover letters that you can work from as well. It is a good idea to skim a few recent articles published in that journal, to know how to format references and other design preferences. The process of submitting a manuscript is time-consuming but generally self-explanatory. Your mentor is available to assist, and, in most circumstances, your attending should be listed as the “Corresponding Author.” The more of the legwork that you can do independently, however, the more satisfaction at the time of submission.

If your manuscript is rejected, do not fret—this is a common occurrence, with studies showing that many published studies have been rejected at least once.^{18–20} Even well-established researchers often have manuscripts rejected. Do not give up on yourself or on the project. Discuss the feedback with your mentor, make appropriate edits as suggested by the reviewers, and then reformat and submit to another journal. If your manuscript is provisionally accepted, you will also likely have to make edits. Work with the senior author on this step—they can provide guidance on the appropriate response to these critiques. While it is normal to have an initially defensive response to reviewer feedback, it is more productive to approach these comments with an open mind. These comments may provide helpful guidance to improve weak areas in your manuscript. If some of them seem like the reviewer “did not understand the paper,” ask yourself why that is and how you can reorganize or rephrase parts of your manuscript to clarify, not just to the reviewer but to your eventual readers.²¹ Avoid the urge to simply resubmit the exact same manuscript to another journal—not only is this a missed opportunity to improve your work, but experts in the topic are likely to serve as reviewers for more than 1 journal, and journal editors are wise to this practice.^{22,23}

Regardless of the outcome of manuscript submission, you will have gained valuable knowledge and experience by performing your study. You will understand the intricacies (and limitations) of research, you will be able to approach published studies with a more critical eye, and you will have obtained insight in how to propose and perform your own research studies, should you wish to in the future.

Good luck!

This manuscript grew out of a discussion on Twitter, initiated by Dr Gonzalez. The authors thank all respondents who made initial contributions to this project via that discussion.

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