EMERGENCY CARE RESEARCH A PRIMER

EDITORS | Vikhyat S. Bebarta, MD, FACEP | Charles B. Cairns, MD, FACEP

American College of Emergency Physicians®
ADVANCING EMERGENCY CARE

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EDITORS

Vikhyat S. Bebarta, MD, FACEP

Charles B. Cairns, MD, FACEP

Section of Emergency Medicine Research and Research Committee

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PUBLISHER'S NOTICE

ACEP STAFF

Marjorie Geist, RN, PhD, CAE, *Staff Liaison*

Nissi George, *Production Assistant*

CONTRIBUTORS

Jill M. Baren, MD, MBE, FACEP, FAAP
Professor and Chair, Department of Emergency Medicine
Perelman School of Medicine
University of Pennsylvania
Chief, Emergency Services
University of Pennsylvania Health System
Philadelphia, Pennsylvania

Vikhyat S. Bebarta, MD, FACEP
Lieutenant Colonel, USAF, MC
Chief, Medical Toxicology
Department of Emergency Medicine
San Antonio Military Medical Center
San Antonio, Texas

Keith Borg, MD, PhD, FACEP
Assistant Professor
Division of Emergency Medicine
Medical University of South Carolina
Charleston, South Carolina

Charles B. Cairns, MD, FACEP
Professor and Chair
Department of Emergency Medicine
University of North Carolina
Chapel Hill, North Carolina

Judd E. Hollander, MD, FACEP
Professor, Clinical Research Director
Department of Emergency Medicine
University of Pennsylvania
Philadelphia, Pennsylvania

Debra Houry, MD, MPH, FACEP
Vice Chair for Research, Emergency Medicine
Director, Center for Injury Control
Associate Professor, Emergency Medicine
Emory University
Atlanta, Georgia

Renee Y. Hsia, MD, MSc, FACEP
Assistant Professor
Department of Emergency Medicine
University of California, San Francisco
San Francisco, California

Edward C. Jauch, MD, MS, FACEP
Professor
Interim Chief and Research Director
Division of Emergency Medicine
Professor
Department of Neurosciences
Associate Vice Chair Research
Department of Medicine
Medical University of South Carolina
Charleston, South Carolina

Heemun Kwok, MD, MS
University of Washington School of Medicine
Harbor-UCLA Medical Center
Los Angeles Biomedical Research Institute
Torrance, California

Roger J. Lewis, MD, PhD, FACEP
Vice Chair, Academic Affairs
Department of Emergency Medicine
Harbor-UCLA Medical Center
Torrance, California

Edward A. Panacek, MD, MPH, FACEP
Professor
Clinical Trials Director
Department of Emergency Medicine
University of California, Davis
Davis, California

Willard W. Sharp, MD, PhD, FACEP
Assistant Professor of Medicine,
Section of Emergency Medicine,
Department of Medicine
University of Chicago
Chicago, Illinois

Adam J. Singer, MD, FACEP
Professor and Vice Chair for Research
Department of Emergency Medicine
Stony Brook University
Stony Brook, New York

Terry L. Vanden Hoek MD, FACEP
Professor of Emergency Medicine,
Department of Emergency Medicine
University of Illinois at Chicago
Chicago, Illinois

Donald M. Yealy, MD, FACEP
Chair, Department of Emergency Medicine
University of Pittsburgh/University of Pittsburgh Physicians
Professor of Emergency Medicine, Medicine, and Clinical and Translational Sciences
University of Pittsburgh School of Medicine
Pittsburgh, Pennsylvania

John G. Younger, MD, MS, FACEP
Associate Professor
Associate Chair for Research
Department of Emergency Medicine
University of Michigan
Ann Arbor, Michigan

TABLE OF CONTENTS

PREFACE

Many emergency medicine clinicians engaged in research may not be aware of some fundamental principles of conducting and disseminating medical research. Ignorance of these fundamentals can lead to investigator frustration, disorganized researcher efforts, and ultimately a reduction in the emergency care researcher pool.

Conversely, an increasingly large pool of trained investigators has focused their efforts toward emergency care research. Giving these investigators an overview of the unique challenges and opportunities in emergency care research could be valuable, if not critical, to their success in investigations.

The field of emergency medicine now has experienced and funded emergency care researchers who can highlight key points to finding mentors, obtaining extramural funding, designing research proposals, initiating research, and disseminating research results. Some of this information has been presented in lectures, discussed at national meetings, printed piecemeal in review articles, and published in lengthy books. However, a pithy, consolidated, and accessible guide focused on the junior, novice, or evolving emergency care investigator has not been available.

The American College of Emergency Physicians' (ACEP) Emergency Medicine Research Section and Research Committee recognized the need for a short manual to kindle and motivate trainees and novice investigators and to offer an introduction to emergency care research with a hands-on guide to initiating, completing, and disseminating research.

The chapters in this manual address what constitutes emergency care research, how to identify a research topic and find a mentor, how to address key issues in emergency care research, training in research, the basics of grant writing, the presentation of research results, getting published, the top commandments of emergency care research, and how to start a research career.

We hope that this primer serves as a resource for everyone engaged in emergency medicine to both motivate and encourage investigators to pursue emergency care research.

Vikhyat (Vik) Bebarta, MD, FACEP
Co-editor

Charles (Chuck) Cairns, MD, FACEP
Co-editor

WHAT IS ACUTE AND EMERGENCY CARE RESEARCH?

Charles B. Cairns, MD, FACEP

OVERVIEW OF EMERGENCY CARE RESEARCH

Emergency medicine evolved as a medical specialty from a convergence of events stemming from transformations in hospital systems and changing societal perceptions of access to medical care. Increasing patient loads in hospitals resulted in a need for dedicated staffing of emergency departments (EDs). In addition, lessons from combat had highlighted the importance of timely management of traumatic wounds and the potential for out-of-hospital care (1).

The integration of these care systems and the development of resuscitation medicine lead to a remarkably expansive specialty that now delivers care to over 120 million patients annually in the nation's EDs and has resulted in the training and board certification of over 20,000 emergency physician specialists (2).

As the specialty grew rapidly, questions arose about the future of emergency medicine research. The Josiah Macy Jr. Foundation convened a meeting to investigate the role of emergency medicine in the future of American medical care (1). The participants at this and subsequent follow-up conferences (1, 2, 6, 8, 9) noted several unique factors to emergency medicine and emergency medicine research:

- Emergency medical care is the only medical care resource that offers both immediacy of care and universality of service.
- Emergency medicine encompasses and interacts with all medical specialties.
- Emergency departments are literally the front door for the sickest and worst injured in America.
- The import of immediacy of care has been proven time and again by research performed in the ED setting, including the very time sensitive treatments of heart attacks, stroke, shock states, pneumonia, respiratory illness, and trauma.
- Emergency departments function as a safety net for our health care and social systems and are the only institutional providers mandated by federal law to treat anyone who presents for care.

- Emergency medicine encompasses all patient populations, traverses all geographies, and interacts with every culture, race, creed, and socioeconomic class.
- Emergency physicians have become experts in rapid risk stratification and diagnoses.
- The science of short-term risk stratification, often on undifferentiated conditions with inadequate historical data, has been necessarily one of the main focuses of emergency medicine research.
- The rapid and accurate diagnosis of potentially life-threatening conditions is another nucleus of emergency medicine research and is the arena in which many new technologies are first studied.
- Research into and the administration of emergency medical services (EMS) and the resuscitation from cardiopulmonary arrest have become almost completely encompassed within emergency medicine.

Thus, emergency medicine has a unique perspective in medical care by dealing with time-sensitive and life-threatening disease processes across broad populations and geographies. The clinical practice of emergency medicine encompasses a wide variety of populations presenting with undifferentiated conditions and therefore providing distinct research opportunities. Evidence-based improvements in emergency care have been shown to improve immediate morbidity and mortality as well as affecting long-term outcomes.

While there has been remarkable growth in the number of emergency care patients, emergency physicians, and emergency medicine training programs, there remain unique perspectives and challenges to emergency care that will require marked expansion of research endeavors. Future emergency care should be guided by evidence and based on high-quality research performed by well-trained investigators who have a realistic perspective on this challenge. Given the scope of emergency care, advances in emergency medicine research may be one of the most important areas of health care within the next decade.

DEFINITION OF EMERGENCY CARE RESEARCH

The broad scope of emergency care is reflected in the domains of emergency care research. The emergency care patient population is diverse and includes pediatric, geriatric, medically underserved, and minorities, as well as those with acute illness, exacerbation of chronic illnesses, and injuries (2). Correspondingly, emergency care research domains are broad in scope, covering broad ranges in the timing and scale of the entities being studied (Figure 1-1). Thus, emergency care research spans time-sensitive emergency care as well as chronic care, individual organ systems, regionalized health care systems, and population health.

Three key aspects of emergency care research stand out (10):

1. *Severity* — life-threatening illness and injury

2. *Vulnerability* — all-inclusive populations, including geriatrics, pediatrics, and psychiatry

3. *Time sensitivity* — conditions marked in time-frames of minutes to hours

Thus, emergency care research may be defined as "*research [that] focuses on the discovery and application of time-critical diagnostics, decision making and treatments that save lives, prevent or reduce disability, and restore human health*" (10).

A global hypothesis for emergency care research is that "*rapid diagnosis and early intervention in acute illness [and injury] or acutely decompensated chronic illness improves patient outcomes*" (5). Consistent with this hypothesis, there are a number of emergency care interventions that have been shown to reduce mortality and improve outcomes for patients with acute, time-sensitive illness or injury (Table 1-1).

FIGURE 1-1.

Examples of Emergency Care Research Domains
(*from the NIH Roundtable on Medical and Surgical Emergencies [2]*)

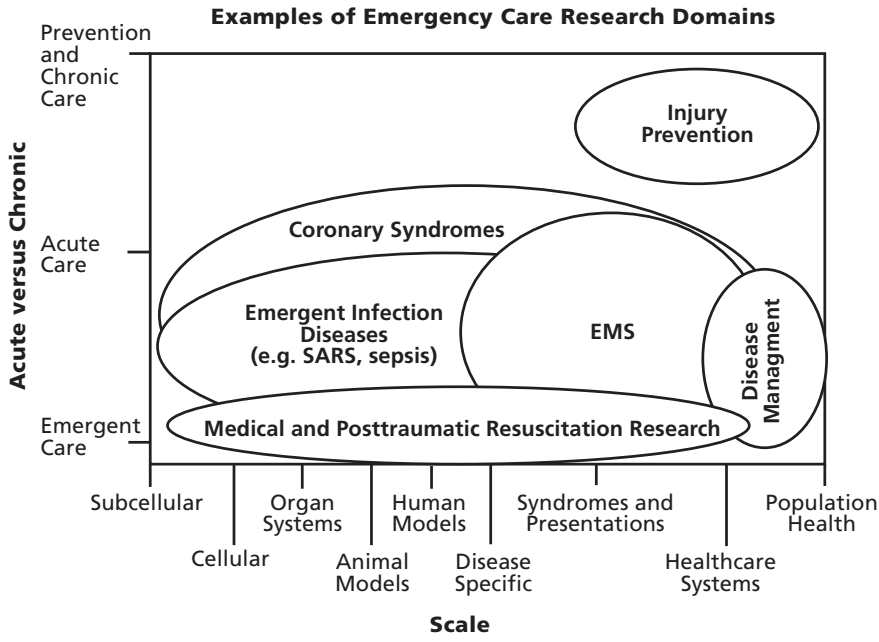

TABLE 1-1.

Emergency Department Interventions that Reduce Mortality and Improve Outcomes

1. Timely administration of aspirin and fibrinolytic therapy for acute myocardial infarction

2. Percutaneous coronary intervention (PCI) within 90 minutes for ST-segment elevation myocardial infarction (STEMI)

3. Appropriate empiric antibiotic administration within 4–6 hours for pneumonia

4. Early goal-directed therapy (EGDT) for sepsis

5. Blood pressure management for both ischemic and hemorrhagic stroke

6. Therapeutic hypothermia for adults with ventricular fibrillation induced cardiac arrest

7. Administration of antibiotics for open fractures

8. Administration of antidotes, such as N-acetylcysteine for acetaminophen poisoning

From NIH Roundtable on Medical and Surgical Emergencies (2).

IMPORTANT AREAS FOR EMERGENCY CARE RESEARCH

A key characteristic of emergency care is the rapid assessment and treatment of potentially life-threatening illness and injury, often before a definitive diagnosis is possible. Thus, there is a need to rapidly characterize, or *phenotype*, emergency patients on the basis of the severity and acuity of their disease state (2, 8).

Thus, an overarching priority in emergency care research is the development and testing of modalities and strategies for the efficient and rapid identification of serious injury and illness, often in a setting in which the clinical manifestations of the disease may be subtle or nonspecific; the disease prevalence is quite low, but the potential impact of a missed diagnosis or delay in definitive therapy is quite large (e.g., meningitis; myocardial ischemia). The development of such diagnostic strategies will require new and substantive research into underlying mechanisms of disease and injury, including the sequence and timing of events after insult and injury.

In addition, the development of cost-effective, rapid, and accurate ***diagnostic*** strategies to be used in the setting of potentially serious but nonspecific patient presentations (e.g., fever in infants, shock, altered mental status, abdominal pain, chest pain, respiratory distress) will improve health care in two distinct ways:

- Patients *with* serious illness will be more quickly and unambiguously identified, leading to more rapid initiation of effective treatment.
- Patients *without* serious illness will be more rapidly identified, minimize the need for additional testing, reduce unnecessary and potentially harmful empiric treatment, reduce lengths of stay in the ED, and decrease unnecessary hospitalization. These latter effects will reduce ED and hospital crowding, that currently impact the quality of and access to emergency care.

Beyond patient characterization, there is an imperative to develop effective initial ***therapeutic*** strategies for *broad* classes of patients with emergency conditions (e.g., those with shock, altered mental status, and respiratory distress). Furthermore, the process of therapeutic decision making in the emergency setting of diagnostic uncertainty needs to be studied. Equally important is the development of early therapeutic strategies for patients with *specific* time-sensitive illnesses and injuries (e.g., closed head injury; myocardial, cerebral, or mesenteric ischemia; hemorrhagic shock; cardiopulmonary arrest).

The development of novel diagnostic and therapeutic strategies will require new and substantive research into underlying mechanisms of disease and injury. In order to optimize value in the development of emergency therapeutic strategies, mechanistic investigations must pay particular attention to the sequence and timing of pathophysiological events. Furthermore, the effective translation of therapies developed in preclinical models of time-sensitive disease states to the clinical research setting will require the enrollment of research subjects early in their clinical course when such therapies are most likely to be effective.

RESEARCH AGENDAS FOR EMERGENCY CARE

Emergency care research has been the subject of two important research agenda setting efforts. The Macy Foundation reports suggested these specific recommendations for the further evolution of emergency medicine research (1):

- Enhance support for basic, clinical, and health services research pertinent to emergency medicine practice.
- Promote collaborative and interdisciplinary research within and across traditional institutional boundaries.
- Develop new systems to manage clinical information.
- Develop new methods to assess the outcomes of emergency care.
- Seek and develop increased funding sources for emergency medicine research.

More recently, the Institute of Medicine Committee on the Future of Emergency Care in the United States Health System convened and identified a crisis in emergency care in the United States, including a need to enhance the research base for emergency care (7). As a result, the National Institutes of Health (NIH) formed an NIH Task Force on Research in Emergency Medicine to enhance NIH support for emergency care research. Members of the NIH Task Force and academic leaders in emergency care participated in three Roundtable discussions to prioritize current opportunities for enhancing and conducting emergency care research (2, 8, 9). The Roundtables were focused on: (a) neurological and psychiatric emergencies; (b) medical and surgical emergencies; and (c) emergency trauma.

The objectives of these NIH Roundtables were to identify key research questions essential to advancing the scientific underpinnings of emergency care and to discuss the barriers and best means to advance research by exploring the role of research networks and collaboration between NIH and the emergency care community. The key themes of each of the three Roundtable reports are highlighted in Table 1-2.

Overarching themes of the NIH Roundtable reports included (2, 8, 9):

- Emergency care research is characterized by focus on the timing, sequence, and time sensitivity of disease processes and treatment effects.
- Rapidly identifying the phenotype of patients manifesting a specific disease process, and the mechanistic reasons for heterogeneity in outcome are important challenges in emergency care research.
- Need to elucidate the timing, sequence, and duration of causal molecular and cellular events involved in time-critical illnesses and injuries, and the development of treatments capable of halting or reversing them.
- Need for novel experimental models of emergency conditions.
- Understand regional differences in outcome for the same emergency disease processes.

In addition, a number of important barriers to emergency care research were identified in the NIH Roundtable reports (2, 8, 9), including:

- Limited number of trained investigators and experienced mentors in emergency care research.
- Limited emergency care research infrastructure and support, and regulatory hurdles.

The NIH Roundtables recommended that the science of emergency care may be advanced by facilitating the following: (a) training of emergency care investigators; (b) development of emergency care clinical research networks; (c) emergency care–specific federal research initiatives; (d) involvement of emergency specialists in grant review and research advisory processes; (e) support learn-phase and adaptive clinical trials; and (f) performance of research to address unique ethical and regulatory issues in emergency research.

CONCLUSIONS

Emergency medicine research involves the study of time-sensitive, severe disease conditions that impact broad populations. The hypothesis that time makes a difference has been proven in multiple emergency conditions. These successes have led to the development of a compelling research agenda for emergency care. Enhancement of the research basis for emergency care will require progress in mechanistic, translational, and clinical domains as well as collaboration of investigators across traditional clinical and scientific disciplines. In addition, emergency care researchers will need to overcome limitations in available infrastructure, research training, and access to emergency patient populations (2, 8, 9).

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TABLE 1-2.

Key Themes from the NIH Roundtable Reports on Emergency Care Research (2, 8, 9)

- **Emergency care research** focuses on the **timing, severity**, and **acute sensitivity of disease and treatment**
- **Rapidly identifying the phenotype** and genotype of patients for a specific disease and mechanistic reasons for heterogenieity
- Elucidate the timing, **sequence, and duration of causal molecular and cellular events** involved in time-critical illnesses and injuries
- **Treatments capable of halting or reversing** them
- **Emergency care is an integrated system** from emergency medical services dispatch to discharge
- **Understand regional differences** in outcome for the same disease processes

HOW TO PICK AN EMERGENCY MEDICINE RESEARCH TOPIC

Charles B. Cairns, MD, FACEP

Vikhyat S. Bebarta, MD, FACEP

Edward A. Panacek, MD, MPH, FACEP

IMPORTANCE OF THE RESEARCH TOPIC

A key challenge to having a successful research project, one suitable for publication or grant funding, is the identification of an interesting research topic and the design of a research approach that will be able to answer the question of interest. Many clinically based investigators find a research topic by examining clinical practice looking for important clinical challenges. Other approaches include inspiration from the clinical or scientific literature and attending conferences or lectures both within and outside of emergency medicine.

Frankly, most successful researchers have learned their topic selection and research skills from a research mentor as part of an integrated research training program. All of these mentors share some combination of the attributes of curiosity, energy, innovation, scholarship, patience, and intelligence.

This chapter emphasizes a practical approach to the identification of research topics of importance to emergency medicine researchers and to the development and communication of research projects competitive for publication and grant funding.

BROAD RESEARCH AREAS IN EMERGENCY MEDICINE

Emergency medicine is the only medical care resource that offers both immediacy and universality of service. Thus, emergency medicine is concerned with clinical conditions that are time-dependent, carry high morbidity or mortality, involve diagnostic uncertainty, and affect traditionally underserved populations (1, 2). Thus, emergency medicine researchers have a wide array of potential areas of study.

The Macy Foundation project on the future of emergency medicine highlighted the need to develop a research agenda for emergency medicine. Follow-up projects (2, 3) suggested that emergency medicine research efforts be prioritized toward:

1. Elucidation basic mechanisms, pathophysiology, and treatments of life-threatening conditions.
2. Perfection of techniques, modalities, and technologies to rapidly diagnose and manage ED patients, with particular emphasis on atypical or undifferentiated signs and symptoms.
3. Definition of the optimal role and configuration of emergency care services in a population-based system of care.

RESEARCH DIRECTIONS IN EMERGENCY MEDICINE REPORT ON OUTCOMES RESEARCH

Outcomes research was identified as a major area of need in emergency care and there was a call for the development of new methods to assess acute care outcomes (3). In addition, the following were recommended as focus areas for outcomes studies in emergency medicine:

1. Contribution of the emergency care–related services to the overall episode of care.
2. Use of epidemiologically based methods to identify populations at risk for emergency events.
3. Identification of disease-specific acute care outcome measures.
4. New methods to assess the effect of acute interventions on quality of life.
5. Measurement tools to assess the risk-adjustment of acute care patients.
6. Management tools to evaluate the impact of the marginal costs of emergency medical care.
7. Methods to rapidly and effectively communicate diagnostic and treatment choices to patients having acute events.

The Macy Research Directions in Emergency Medicine Reports also highlighted research funding strategies, the value of research collaborations, developing the emergency medicine research infrastructure and database and informational management strategies (2–4).

RESEARCH PRIORITIES IN EMERGENCY MEDICINE

The Institute of Medicine Committee on the Future of Emergency Care in the United States Health System convened and identified a crisis in emergency care in the United States, including a need to enhance the research base for emergency care (5). As a result, the National Institutes of Health (NIH) formed an NIH Task Force on Research in Emergency Medicine to enhance NIH support for emergency care research. Members of the NIH Task Force and academic leaders in emergency care participated in three Roundtable discussions to prioritize current opportunities for enhancing and conducting emergency care research (6–8). The Roundtables were focused on (a) neurological and psychiatric emergencies, (b) medical and surgical emergencies, and (c) emergency trauma.

The objectives of these NIH Roundtables were to identify key research questions essential to advancing the scientific underpinnings of emergency care and to discuss the barriers and best means to advance research by exploring the role of research networks and collaboration between NIH and the emergency care community. While the key themes and research priorities of the three Roundtable reports are highlighted in Chapter 1 (*What Is Emergency Care Research?*), the overarching messages of the NIH Roundtable reports included (6–8):

- Emergency care research is characterized by focus on the timing, sequence, and time sensitivity of disease processes and treatment effects.
- Rapidly identifying the phenotype of patients manifesting a specific disease process and the mechanistic reasons for heterogeneity in outcome are important challenges in emergency care research.
- Need to elucidate the timing, sequence, and duration of causal molecular and cellular events involved in time-critical illnesses and injuries, and the development of treatments capable of halting or reversing them.
- Need for novel experimental models of emergency conditions.
- Understand regional differences in outcome for the same emergency disease processes.

There is a need to rapidly characterize, or phenotype, emergency patients on the basis of the severity and acuity of their disease state (6–8). Thus, a priority in emergency care research is the development and testing of rapid diagnostic strategies. In addition, there is a need to develop and test therapeutic strategies for patients with emergency conditions. The NIH Roundtable reports are a valuable source for research topics as they provide specific guidance on which emergency conditions have been prioritized in federal research agendas.

TURNING THE TOPIC INTO A PROJECT

Once a research area of interest has been identified, it is important to evolve the topic into a successful research project.

For novice and junior investigators, it will be important to identify a research mentor who has expertise in research design, a record of productivity in publications and grant funding, and interest in mentoring evolving investigators (see Chapter 3 [*Why Do I Need a Mentor?*]). In our experience, initial projects for novice emergency medicine investigators usually focus on conditions involving:

- Life-threatening conditions (severe distress or disease)
- Time-sensitive conditions (characterized by minutes, hours and days)
- Common disease conditions (undifferentiated signs and symptoms; large populations)
- Conditions with defined follow-up time-frames (days to weeks)
- Population or geographically based systems (emergency medical services)

For more experienced investigators, we have identified key elements in research design that are fundamental to successful grant applications (9). In weekly interdisciplinary research conferences, we emphasize the incorporation of these elements into manuscripts and grant applications. Ideally, our goal is to present a series of hypothesis-driven, mechanistically based, logically sequential, highly focused studies with direct application to clinical medicine performed by a superior emergency medicine clinician investigator. While this lofty goal has not been completely achievable, the following components represent significant intermediate goals.

Hypothesis-driven. The study is supported by a well-articulated, imaginative, and testable hypothesis. It is not a broad-based inquiry hoping to find something interesting (sometimes referred to as a fishing expedition) or a project solely focused on finding that drug or procedure X is helpful (sometimes referred to as "product testing").

Mechanistically based. The project should not only describe an interesting phenomenon but also seek to explain how it works (the "mechanism of action"). Once a mechanism of action is discovered, it can lead to further projects on how the phenomenon can be therapeutically manipulated or applied to other problems of biological or clinical interest.

Logically sequential. Truly elegant studies are ones that identify and explain the entire chain of events associated with the phenomenon. In basic science studies, a project might seek to explain a phenomenon, such as ischemic preconditioning, from the molecular, cellular, and physiological perspectives. Clinical studies might seek to explain the pathophysiological basis of a disease such as asthma, the mechanism of action of a particular intervention on the disease state, and the effect of this intervention on the lives of patients with the disease.

Highly focused. Each study in a project should be delineated precisely into a series of experiments that can be packaged and published as discrete manuscripts. We emphasize that you never propose a study that will take longer than approximately 6 months to complete. We are continuously amazed by the complexities that evolve from even the most focused projects.

Superior clinician/investigators. Emergency medicine clinicians who are well-trained investigators are in a unique position to gain insight into complex clinical entities by directly translating potential mechanisms of disease relevant to that entity, and vice versa. Training can be accomplished by a combination of working directly with an experienced research mentor and formal course work.

CONCLUSIONS

A key challenge to a successful research project is the identification of an interesting research topic and the design of a research approach that will be able to effectively answer the question of interest. There are a wide range of research topics within emergency medicine, and most focus on clinical conditions that are time-dependent, carry high morbidity or mortality, involve diagnostic uncertainty, and affect traditionally underserved populations. Once a research area of interest has been identified, it is important to evolve the topic into a successful research project. For novice and junior investigators, it will be important to identify a research mentor to help in research topic selection. More experienced investigators should pursue topics that allow for a series of hypothesis-driven, mechanistically based sequential studies.

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WHY DO I NEED A MENTOR, AND HOW DO I FIND ONE?

Judd E. Hollander, MD, FACEP

Renee Y. Hsia, MD, MSc, FACEP

INTRODUCTION

Mentorship is one of the key ingredients to the success of any junior emergency care researcher. While there are examples of successful researchers who did not have good mentorship, these are more exceptions rather than the rule. In this chapter we hope to provide the junior investigator with a rationale for expending the time and energy to develop one or more mentor-mentee relationships. We will review the importance of receiving mentorship, assessing your own needs, finding the "best fit" mentor, and how the role of the relationship(s) may change as your career progresses.

WHY IS HAVING A MENTOR IMPORTANT?

Provide advice

Perhaps the most important overarching goal of having a mentor is to provide counsel on how you can achieve your goals. The benefits of mentorship span the range from advising on the nitty-gritty (e.g., advising you on education and coursework, even specific classes) to larger questions of life (e.g., career opportunities, nonresearch trajectories should research not work out), and mostly the in-between (e.g., deadlines, helping set priorities, mapping out a research career). In short, a mentor can help provide structure to the otherwise unstructured academic pathway.

Define your focus

It is not unusual for someone beginning a research career to want to be a successful sustained investigator, have a continuous source of funding, and answer research questions that they find important. As emergency medicine is a broad field with plenty of unanswered questions, beginning researchers may not have a clear idea on where they wish to focus. A mentor can help you develop focus.

Scientific focus. The questions that interest you may determine whether funding will be forthcoming. They may be important questions but may not be aligned with the strategic goals of a particular funding source. Your chances of obtaining funding are linked to the ability to align your questions to the strategic goals of funding agencies or foundations. If the broad question or focus that you are contemplating is not aligned with the desires of a funding agency, your likelihood of success is greatly reduced.

You may or may not be able to answer your specific questions in your specific setting. For example, if you were interested in studying otitis media but worked in an adults-only hospital, you most likely would have an insufficient number of patients for a comparative effectiveness trial. Being able to bounce ideas off a seasoned researcher may allow you to determine whether your questions can be answered at your institution, whether you have resources available to answer them, and whether the questions fit within the mission of a potential funding source. Participation in these discussions with your mentor will allow you to tailor your goals so that they are more likely to be successfully accomplished (and funded).

Identify funding opportunities. Once you have developed at least a preliminary scientific focus, it is always helpful to have an army of people sending you appropriate funding announcements. Although you can identify agencies or foundations that notify investigators of new announcements, a mentor can help you focus on items likely to be high yield and not just notices that fill your inbox. They can also send things your way when opportunities arise. Although not obvious, funding priorities get determined by investigators who sit on advisory boards to foundations. Meeting these people, knowing their priorities, and being able to market your own ideas might just lead to someone requesting funding for your specific area of interest. A mentor can facilitate these meetings, as well.

Selecting publication venues. We believe that all individual projects should have goals set at the outset. You should obviously answer the relevant question, but you also should balance scientific rigor with practicality. Not all studies can be done perfectly, but it does not mean that you cannot move the field ahead. Having an idea of time and resources that can be devoted to a project should allow you to target specific journals. Knowing the preferences of general medicine versus emergency medicine target journals allows you to design your study with this information in mind. For example, *JAMA* does not often publish single-site studies of common conditions. It does often publish large dataset analyses and health services research. Some journals in our specialty lean toward prospective clinical trials (even if single site) and shy away from large registry analysis. Your mentor can have you better focus your expectations, even before you collect and analyze the data.

Enhance collaborations and networking opportunities

A mentor can help you network. Networking is not just about meeting people in the hallway and shaking hands and saying hello. It is about getting to know people, what makes them tick, and how you can work symbiotically to achieve common goals. Developing long-term relationships in our specialty enhances individual productivity. Mentors can point you to specific scientific conferences (locally, nationally, and internationally) where you can meet people who share your academic interests, whether they are in emergency medicine or another specialty with an interest in emergency care research. Mentors can develop a list of people whom you should meet. They can suggest committees where you would meet colleagues with similar interests or get to know decision makers that might impact your likelihood of getting funded. Conversely, they can identify offers that will just be a time sink and will not be productive for your career pathway. Avoiding unproductive endeavors is a key to success.

Mentors can help you make correct decisions regarding your own optimal balance between work and non-work life. Some colleagues often bring their significant other to scientific meetings and sneak away for a day or spend the evening with their family. This is perfectly fine, but it will decrease the amount of networking that can occur at that meeting. It should be obvious that your career will advance more if you spend time interacting with colleagues at the meetings. Your marriage might not. Clearly both are important. Deciding to prioritize your family life at the meeting will make your networking less productive. Mentors can help you balance decision making so you can optimize both your work and your nonwork life in the manner of your choosing, but young investigators need to realize that full integration is often not the best approach to satisfy either desire.

Market you and develop your reputation

A mentor can help market you and your knowledge, skills, and abilities. A well-experienced mentor should have connections to the editors of journals and enable you to become a reviewer and gain valuable experience critiquing manuscripts. Senior investigators often receive invitations to write chapters, editorials, or invited reviews. If you share an area of scientific expertise, you should have the opportunity to collaborate on these types of projects. Many mentors, particularly clinical and health services researchers, have extensive networks of collaborators. They should be able facilitate your collaborative opportunities and get you involved as a co-investigator on their own and other investigators' grants. By recommending you for national committee service, your mentor can place you in the room with many leaders of your specialty so that your skills set can be appreciated by them.

Provide structure, review, and assist with project development

Ultimately, your success will depend on your productivity. Although your mentor should help you establish connections and place you in the right environment to enhance recognition of your skills set, the most important concrete value that is needed from your research mentor is scientific advice that improves the quality of your research. The mentor can also facilitate acquisition of needed resources, whether it be statistical packages, lab space, or biobanking facilities.

Your research mentor should be able to assist with study design, obtaining preliminary data, grant preparation, and development of a team of collaborators that predicts a high likelihood of success. Ideally, regular meetings as your project progresses will help challenge you to improve the design and be able to ask the important questions. It is important that the mentor not just pat you on the back, but rather challenge you to design the best possible study that can realistically be accomplished. In the end, a mentor's success is measured by the success of the mentee.

Debriefing

Like most things in life, there will be some setbacks. Having someone listen to you and provide counsel when difficulties arise is always useful. This may be the failure of an experiment, rejection of a manuscript, a string of unfunded grants, or change in allocation of clinical and research time within the department. Having someone who has succeeded despite these impediments is comforting and can provide direction and help you develop corrective strategies. Most successful investigators have encountered personal difficulties related to their dedication to work. You may find that your research mentor can help provide guidance or you may prefer to have someone else to speak with when these issues arise. Most successful people have more than one mentor.

HOW DO I FIND A MENTOR?

The answer to this question depends on where you are in your career. In general, however, there are certain principles one should adhere to when choosing a mentor. This individual should be committed to the idea of mentoring you as a person, first of all, and secondly be interested in developing your career. Your mentor should have a successful track record of mentoring others and be someone who can and will provide expertise and contacts to create networking opportunities within and across institutions. They should also be someone with whom there is a potential for reciprocity on your (the mentee's) side, as this forms the foundation for longer-term relationships.

The search for a mentor should begin as soon as possible. For those pursuing research fellowships, mentor selection is less difficult if you select a well-designed established fellowship program. There should be designated individuals in place. Therefore, when searching for a fellowship, your likelihood of success will be greatest if you know what you want and you select a training group with a track record of developing successful investigators. Enrollment in a degree-bearing program will facilitate interaction with multiple faculty with training experience.

If you are evaluating first job opportunities, you should consider the availability of mentors during the selection process. If the emergency medicine program does not have a strong research track record, you should interview with and meet faculty outside emergency medicine during your evaluation process. If the emergency physicians cannot identify someone to mentor you, who shares your passion for your area, you will have difficulty being successful.

Often, the question is asked, "What should I do, I want to become a successful researcher and work at xxxxx, but none of their faculty have any research experience?" This is really an easy question to answer — you need to decide between doing research and working at xxxxx. Either is acceptable, but you won't become a successful researcher there. Know this from the beginning. Whether you are geographically mobile or restricted must be taken into account. You should make an informed decision and understand your likelihood of deriving satisfaction or frustration from both the job and family.

Without a formal fellowship program or pathway, the actual "how" of finding a mentor for some can be as time-consuming as "cold-calling" (actually "cold-emailing") individuals for whom there might be even a small possibility of an intersection of research interests.

A real description from someone who went to an institution without an emergency medicine training track record follows:

> I spent the first year on faculty writing my own K proposal and trying to find a senior researcher at the institution who was already well-funded to agree to be my mentor. Over the course of the year, I emailed perhaps 50 individuals and met with those who replied: explaining my background, "shopping" around my ideas, and hoping that they would agree to be my mentor. I met with disappointment almost every time — not that they were not willing, but that they did not feel that it would be a good fit, or that they were at this time unavailable to provide me the mentorship that I needed. The reasons mainly centered around the fact that I was coming from a department that did not have the research infrastructure to support me, and that they were in departments that were pressuring them to be mentors for the junior faculty already within their department.
>
> While each of these meetings were at times disheartening, overall, it did allow me to meet with several senior investigators at least once and get an idea of how they ran their department and mentored their junior faculty. In addition, while I did not end up working with most of them, from that time I was able to point others who approached me about research to them if their interests intersected more directly, and also helped me get a better sense of the research community at large. Some were able to point me to other faculty, and this was an unintentional but important form of networking; in fact, from meeting with an individual who pointed me to another

individual who pointed me to another, I was invited to a women's research network. It was at one of these dinners (full of estrogen) where I actually teared up about not being able to find a mentor, and how I would be ultimately unsuccessful in this pursuit of research, and eventually one mid-career investigator at this dinner emailed me later to introduce me to an R01-funded researcher within the Department of Medicine at another hospital (but still within my health system) who agreed to be my primary mentor on my K award and signed off on my K proposal.

Even now, though, while I did find someone to be my mentor for my K award and got funded for that award and a few others, I find myself in the predicament of not really having someone to guide me and still feel like I lack a true mentor. Since I wrote almost 100% of those proposals on my own, I feel 'stuck' because I don't know how to expand my research or really engage even in conversations with my mentor about developing it further since we work in quite different fields. I have found groups like SAEM helpful in putting me in touch with other more senior researchers and maybe need to reevaluate finding a more suitable mentor for this next stage. But yes, this is what I'm learning: finding a mentor is key — not just for the very beginning, but throughout the whole process. It's not just getting someone to sign off, it's developing a true relationship, and that's really hard to find.

As highlighted by this individual's experience, having a mentor is a dynamic process. As your career progresses it will become even more important to define the type of mentorship you need most. When you evaluate potential mentors, you should determine the best fit. The best fit can be determined by assessing research interests, personality, availability, and geography (in your department, institution, or not). Availability (time) should also be assessed. You will need to be able to match your needs with their time availability. You may have needs that are easily anticipatable and can be scheduled or needs that might commonly be urgent. Your mentor should be able to fulfill those needs.

Can one mentor do it all?

Mentorship is rarely an "all-in-one" package. You may need to have different types of mentors. Especially in the field of emergency medicine, there will unlikely be one person who can fulfill all the different needs of a mentee. Mentees should select mentors to fill their needs. Career mentors may not be able to inform the specific research questions of the mentee, for example, but can provide overall direction and advice about career trajectory and big-picture questions. Research mentors may not be able to speak specifically on career issues faced by the mentee but are crucial to developing the research agenda of the mentee. Co-mentors also can provide input on more specialized conduct and also may provide opportunities for other collaborations or work.

Many people have a research mentor, a career mentor, personal mentor, etc. It may be project specific advice, career advice, or personal advice that you need. You may want local, national, or international networking.

Sometimes the line between mentor and personal friend can become blurred when one person serves both roles. There is nothing intrinsically wrong with this, but both parties should be aware when this occurs. In settings with strong personal bonds, the mentor's advice can occasionally become tainted by their own personal interests. One example would be when competitive job offers arise. Not wanting your mentee to leave your shop might result in not giving the best advice.

WHAT DO MENTORS WANT FROM A MENTEE?

Mentors uniformly want their mentees to be productive and successful. They also generally like their mentees to be respectful, be committed, and have a strong work ethic. By being organized, planning for your meetings, showing up on time, and meeting deadlines the mentee can demonstrate a commitment to the relationship.

It is critical that the mentor and mentee have similar expectations about the roles they will each play. In this 24-hour-a-day e-mail world, both need to understand the acceptable time frame to respond to each other. The mentee should understand that the whole world does not revolve around him or her. The mentor should understand that oftentimes the mentee hits a wall and cannot move forward without advice from him or her.

We believe that mentees should bear most of the responsibility for initiating impromptu meetings and pursuing an intentional mentor-mentee relationship. This can range from setting up scheduled meetings (discussed in the next section) and, depending on the mentor (e.g., career mentor, scholarly mentor) to actively creating a career development or research development plan to discuss and reevaluate with the respective mentor at designated times, even if just once or twice a year. Reviewing these short-term and long-term professional goals can be important in giving the mentor a clearer idea of where the mentee wants to be and how to help her or him achieve those goals.

A good mentor will provide opportunity for the mentee, whether it is with individual projects, invited writings or committee work. It is important that the mentor not overwhelm the mentee with too many opportunities. The opportunities should not be so plentiful that they cannot get their primary work done or that it interferes with activities outside of work. Communication and open dialogue about expectations is important at all times.

HOW CAN MENTEES GET THE MOST FROM THE MENTOR-MENTEE RELATIONSHIP?

This is one of the most common questions from mentees. Even with the best, most well-intentioned mentor, the logistics of making the most out of this somewhat artificial but crucial relationship are difficult and should be defined ideally before the beginning of this relationship. Depending on the structure of the department and location of the mentor, a more "freeform" or informal style could work. This is ideal if your mentor is within your department and your offices are located near each other, and there is a fairly predictable amount of regular interaction that comes from that setting.

In many cases mentors may be found outside of the department, or even a different hospital. In this situation, regular scheduled meetings are ideal. Without regular, scheduled interactions, it would be difficult to extract any benefit from these relationships. Regularly scheduled meetings should be established, even if there are no "issues" to discuss beforehand. While this may seem to counter every time management argument about only scheduling meetings with defined agendas, for these relationships we would argue that the concept of having strictly defined issues before every meeting could be counterproductive. For most meetings, of course, there will be natural questions or points of discussion that arise from working on projects together.

One person with such a relationship describes the following advantages of this format:

> … For my primary mentor and me, for example, because many of our areas of research in fact did not overlap, these times could be spent on nonresearch but equally important issues: How do I hire someone? What kinds of human resource rules do I need to be aware of? What kind of direction do you see my line of research going? How do you organize your work? We found that these standing meetings — which we could cancel if there was truly *nothing* we needed to discuss — were beneficial to us.
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> This stands in contrast to my secondary mentor, who was at the School of Nursing and was someone I only met twice — once when I asked her to be my mentor, and another time one year after I was funded to brainstorm some ideas with her. Her research area and expertise are actually quite similar to mine, and [she] is someone who could offer a great deal to my development, but because I did not do a good job in being proactive to schedule meetings with her and pursue this relationship, my ability to develop a particular line of research was compromised due to my own fault.

From experiences like these, we recommend more structured interactions (e.g., meeting at regularly scheduled times) if one has a mentor in another department and especially at another site. Without that, it is difficult to achieve any consistency in the relationship.

For those who are working with mentors within their department or who already have regularly scheduled meetings due to similar research projects, less-structured times are necessary. Even in those cases, however, if one is working with a mentor on a collaborative research project, we recommend developing deadlines regarding when certain goals or tasks will be achieved.

CONCLUSIONS

Mentorship is a key ingredient in the success of a research career. It should not be overlooked. It should be treasured by both the mentor and mentee. Watching a successful mentee flourish can provide the mentor with the same sense of fulfillment as their own success. It is just like raising another member of the academic family.

KEY ISSUES IN EMERGENCY CARE RESEARCH

Jill M. Baren, MD, MBE, FACEP, FAAP

EMERGENCY CARE RESEARCH — DEFINITION, RATIONALE, CHALLENGES

Over the last several decades, the emergence of the specialty of emergency medicine has led to major improvements in the care of patients with a variety of life-threatening conditions. The breadth and depth of conditions cared for in the emergency setting are of such significant magnitude that we must continue to be motivated to study and discover therapies and health care strategies that improve patient outcomes. The breadth and depth of the research programs in our specialty truly mirror our clinical practice. Our niche in the world of research is related to timing, location, and access to care rather than ownership of a specific organ system or set of diseases (1).

Neumar was the first to articulate the fundamental hypothesis of emergency care research as follows: "Rapid diagnosis and early intervention in acute illness or acutely decompensated chronic illness improves patient outcomes" (2). During a recent consensus conference examining the utility of emergency care research networks, participants echoed this sentiment and defined emergency care research as "the systematic examination of patient care that is expected to be continuously available to diverse populations presenting with undifferentiated symptoms of acute illness, injury, or acutely decompensated chronic illness, and whose outcomes depend on timely diagnosis and treatment" (3).

Emergency care research extends beyond the physical boundaries of the ED; the chain of emergency care encompasses out-of-hospital care and short- and long-term care settings and includes both immediate and long-term outcomes of therapeutic interventions and strategies. Emergency care research subjects can be drawn from any number of patient populations but have typically been represented by three groups: (a) those with acute life-threatening illness or injury; (b) those needing intervention for a non–life-threatening episode of illness or injury that requires diagnostic and therapeutic resources only available within an emergency care setting; and (c) those with ambulatory, nonemergent medical needs. It is also important to note that emergency care research may extend beyond the individual patient to the study of an actual system of emergency care delivery and possibly

the effect of that system on the community, with respect to access of care, use of resources, and cost (3).

Emergency care research is distinct in its investigation of time-dependent disease processes or acute injury at the cellular and patient level; it focuses not only on diseases such as acute myocardial infarction, acute stroke, trauma, and sepsis but also on critical presentations such as poisonings, undifferentiated shock, coma, and respiratory failure prior to the establishment of a distinct diagnosis. Another unique feature of emergency care research is its resource-dependent processes, which are obtainable 24 hours a day in the ED, making emergency care settings distinct from other health care delivery environments. These include the around-the-clock availability of emergent diagnostics such as computed tomography and magnetic resonance imaging, specialty consultation, and care for substance and psychiatric related illness (3).

Many life-threatening illnesses and injuries still do not have effective treatments and we have not solved seemingly simple clinical problems despite advances in technology and pharmacology. For example, trials of multiple agents used as neuroprotectants to date have been unsuccessful. Similarly, for subarachnoid hemorrhage and intracerebral hemorrhage, there are no proven strategies for emergency management and no proven definitive treatments. Although research design plays a part in the determination of futility of an intervention, we are still left with a paucity of therapeutic interventions to offer patients who experience devastating injury or illness (4).

The evidence base for the practice of emergency medicine is modest but continually growing and there are an ever expanding number of highly trained, highly skilled emergency medicine clinical researchers. The challenges for clinical research in the emergency setting are similar to those for research for other acute conditions: interventions are unscheduled and occur at multiple locations of care; diverse teams of care providers are involved; therapeutic interventions are extremely time sensitive, which limits the feasibility of informed consent; and there is a need for medical staff interested and trained in this field of research.

CHALLENGES IN EMERGENCY CARE RESEARCH

Key factors that contribute to difficulty in conducting research in the ED are time, money, personnel, conflict of interest, disinterest in research, patient mistrust, and regulatory burden. These are, again, not unique to the emergency setting but indeed may be magnified in a dynamic and rapidly changing clinical environment (Table 4-1).

Often emergency care researchers come up against practitioner bias for existing therapies. This is a relatively common scenario where there is a poor evidence base for currently used therapies. This creates a situation where equipoise is difficult to achieve and may even make certain things impossible to study if clinical practice has drifted in a particular direction and seems to have acquired the moniker of "standard of care."

Recruitment of subjects into emergency care research studies has particular challenges. There is often a lack of privacy for an informed consent discussion and the individuals approached often lack of familiarity with the environment and the emergency health care provider.

The accuracy of data collection in the emergency care setting is an area fraught with concern. Follow-up is uncertain since the goal of emergency clinical care is disposition and there is a mandate to transition the patient to another environment for *definitive* care; hence there is a lack of long-term ownership of the patient/research subject by the emergency care research investigator.

Emergency medicine has been challenged in the development of a qualified workforce of emergency care researchers. There is a shortage of adequately trained laboratory,

TABLE 4-1.

Key Challenges in Emergency Care Research

	TIME	PERSONNEL	ED CONDITIONS
Study population	Life-threatening, acute conditions, unstable physiology	No prior relationship with subject, multiple providers interacting at any given time	Crowding, acuity of other patients
Intervention	Time-sensitive action of drugs or use of devices	Shift work, need to train many staff, on-call research personnel who require travel time	Storage issues for drugs, devices, and other research materials
Data collection	Missed time points	Difficult to maintain quality oversight	Interference due to need for clinical care
Infrastructure	Dependent on intervention	Need to train large number of staff, monitor process	Staff burdens, competing clinical tasks, privacy issues
Individual patient factors	Dependent on intervention	Staff uncomfortable with research personnel	Staff burdens, competing clinical tasks, privacy issues
Informed consent	No family or surrogates present may exclude certain populations	Off-site personnel, large need for training and orientation; language, literacy, and vulnerability issues	Need for clinical care, bias toward staff performing "status quo"
Regulatory issues	Multiple reviews	Inexperience	Competing demands for clinical care

clinical, and health services investigators. To date, too few emergency physicians have undergone rigorous research training. There are few such role models and very few departments of emergency medicine with substantive training opportunities. Historically, many departmental research directors were junior faculty members who lacked formal fellowship training or NIH funding. There is inadequate protected time for research, poorly defined research-based career tracks, and professional incentives that distract investigators from research-based careers. Even academic medical centers with departments of emergency medicine have traditionally valued clinical care over research (5). Recent patterns of academic development in the specialty indicate that this is changing and will be sustained.

There are an inadequate number of interdisciplinary research collaborations and multi-institutional networks performing emergency care research. There are also significant gaps in data linkages and standardization of clinical care and information systems. And finally, funding sources for emergency care research are both inadequate and frequently aligned across disease-specific boundaries that are not particularly relevant to the practice

of emergency care. Emergency patients have nonspecific symptoms and syndromic presentations, making it very difficult to classify important, syndrome-based emergency care research with the current NIH organizational structure, which is disease centered (5).

More than any other area of concern, regulatory barriers are often cited as a substantial barrier to overcome in the conduct of emergency care research. There are specific regulatory statutes that govern research in emergency settings (6, 7). The application of these regulations (waiver of informed consent and emergency exception from informed consent for research under special emergency circumstances) to a given research protocol can be resource and labor intensive. Many local institutional review boards do not have experience with these regulations and, in some cases, local state laws may preempt their use (5). In addition, the Federal Wide Assurance (FWA) program may discourage nonresearch entities such as EMS agencies or community hospitals from participating in NIH-funded research; both are often integral parts of the emergency care system (5).

Emergency patients are uniquely vulnerable to a loss of autonomy in the research process by virtue of being acutely ill or injured, physiologically unstable, emotionally unstable, or economically or socially disadvantaged. All of these conditions may be magnified because of the need for unscheduled care. The informed consent process in the emergency setting must be designed to accommodate vulnerable patients — those with diminished capacity — who may in some cases be the majority of eligible patients for an emergency care research study. Informed consent under these circumstances raises many questions such as who makes the determination of vulnerability or is there a role for surrogate consent? This is often a gray area with little to no regulatory guidance but it is extremely important to include such patients in research studies. Examples of conditions that are associated with increased vulnerability and reduced capacity are traumatic brain injury, long bone fractures with pain, respiratory distress, and any risk for impending physiological deterioration (sepsis, multisystem trauma, acute myocardial infarction, cardiac dysrhythmia).

The broad diversity of ED patient populations contributes to the challenges of recruitment into research protocols. Glickman found that most eligible patients who were able to provide consent participated in emergency care research at about a 70% rate overall, which compared favorably to rates reported for other outpatient clinical settings, for both noninterventional and interventional studies (8). However, there were a number of significant challenges identified that resulted in an inability to enroll a number of otherwise eligible patients, particularly among pediatric, geriatric, and minority patient populations. Pediatric and geriatric patients had the lowest enrollment rates. Unique challenges in the consent process exist for each of these age groups and include issues like altered mental status, the lack of availability of legal surrogates for consent, and parental permission requirements for dual-parent consent depending on risk level and assent from the child (8).

Previous research has also demonstrated underrepresentation of minorities in clinical research, although the reasons for higher rates of refusal among blacks and other groups in these studies are poorly understood and likely multifactorial. There are issues related to trust of health care providers and experience with research in general. Academic urban EDs see a disproportionate number of underrepresented minority patients and disparities in enrollment may have important implications for the interpretation and generalizability of clinical trial results.

Local institutional review boards often have extensive requirements for enrollment of non–English-speaking patients including foreign-language and back-translation of consent documents and research protocols and on-site Spanish-speaking personnel for informed consent discussions, both of which are costly and resource intensive. Sponsors may be unwilling or unable to provide funding for such research-related activities (8).

OPPORTUNITIES AND FUTURE DIRECTIONS

Recognition of the unique challenges of emergency care research is the first step in ensuring continued vital emergency care research activity, and it is critical that emergency care researchers work with sponsors, institutional review boards, emergency medicine colleagues, and other health care providers to educate them about these unique challenges in an attempt to develop creative solutions. Solutions for overcoming barriers are driven by the same unique attributes of the emergency setting. EDs are gateways, the patients are often unknown, their problems are urgent, and contact with the emergency service is brief or episodic. This poses unique problems for identification, consent, and tracking of research subjects that can be enhanced by the development of a research infrastructure that provides tools and innovative strategies. For example, the incorporation of innovative informatics technologies can identify patients across sites from multiple EDs and can boost screening and enrollment procedures.

Collaborative research networks can leverage patient cohorts, financial resources, and share data (4). It is unusual for a single institution to be able to recruit sufficient numbers of eligible patients to definitively answer a critical research question and patient populations, and disease prevalence varies with the regional, urban, and socioeconomic mix of patients that use a particular ED. The results of single-site research protocols are often not completely applicable to other emergency care settings. Multidisciplinary or multisite emergency care research networks can enable the conduct of valid, adequately powered, and generalizable emergency care research.

Some successful ED research programs have developed and implemented comprehensive screening programs using research assistants and are inexpensive and offer credit or real-life experience in exchange for their assistance (9). Such programs can be very effective but often require significant efforts on the part of the investigators for study orientation and training and even small incentives and rewards for staff. Having a research workforce that is separate from those providing clinical care has the advantage of clear division of duties. Clinical personnel are often supportive of research but want help and do not want to collect data and perform measurements for researchers while trying to simultaneously provide high-quality, safe, and efficient care in the ED.

Regulatory barriers present in emergency care research are difficult to overcome and require a great deal of experience and effort. This should not discourage young investigators but rather encourage them to seek advice and support from more experienced investigators and from their institutional research officers and IRB members. A well-thought-out plan and preemptive conversation in advance of submitting a research protocol can save a lot of time and effort and multiple rounds of protocol review and resubmission. The literature contains many studies on informed consent in the emergency setting including studies that have operated under federal regulations that allow investigators to forego prospective informed consent under special emergency circumstances. Emergency care researchers are advised to carefully review these regulations and speak with experienced investigators prior to going forward with a proposed study that they believe meets these criteria. Modified informed consent under emergency circumstances has also been proposed as a better mechanism to address literacy and other issues that arise around informed consent. It is important to realize that these strategies need further study and may be rejected by local regulatory and legal communities.

Creating a culture of multidisciplinary collaboration and forming novel interdisciplinary relationships are necessary steps for the successful planning and execution of an emergency care research protocol. All participating investigators must acknowledge the importance of time-sensitive disease physiology and interventions that fall outside traditional, specialty-specific silos. Emergency care researchers should strive to educate colleagues on these

specifics because their buy-in is critical. Historically, many ED-based studies are designed so that the analysis is limited to short-term outcomes such as physiological surrogate endpoints, resource endpoints such as discharge rates, or, at most, in-hospital mortality (3). Studies and networks that collect clinical and economic outcomes data that demonstrate longer-term gains in health from emergency care interventions are likely to have greater impact and to advance the field. To obtain these kinds of outcome data, there must be effective data linkages, starting with out-of-hospital care, continuing through the ED phase of care, extending through hospitalization, and incorporating outpatient assessments of outcome status (3). As cost-effectiveness research becomes more important, emergency care researchers will be required to demonstrate improvements in long-term disease morbidity, hospital readmission, downstream diagnostic testing, and overall health care resource utilization (3).

Flexibility and adaptability are important traits of the successful emergency care research investigator. The dynamic, highly stressful environment of the ED make it extremely challenging to consistently perform high-quality research. Emergency care investigators who are committed to continuous improvement of the processes of screening, enrollment, informed consent, protocol adherence, meticulous data collection, and data sharing as well as collaboration and hard work will be rewarded with the satisfaction of conducting research under some of the most challenging conditions and with the knowledge that they have made a substantial impact on the future care of emergency patients.

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KEY ISSUES IN BASIC SCIENCE EMERGENCY CARE RESEARCH

Willard W. Sharp, MD, PhD, FACEP

Terry L. Vanden Hoek, MD, FACEP

INTRODUCTION

Emergency medicine since its beginnings has been viewed by critics as a specialty that arose from societal and economic needs rather than as an outgrowth of new knowledge or scientific thought. Too broad in scope to have a pathophysiological foundation, emergency medicine is often seen as a borrower or integrator of knowledge from other specialties, lacking a true scientific core. However, emergency medicine specialists have long argued for a "biology of emergency medicine" that bundles the resuscitation, stabilization, and caring of the acutely ill and dying (1, 2). In contrast to studies related to mechanisms of chronic disease, basic science emergency medicine research focuses on the time-sensitive mechanisms of diseases that affect outcomes of critical care (3). Time-sensitive interventions initiated within minutes and hours of patient presentation directed at cellular, tissue, and systemic targets may improve clinical outcomes in conditions as diverse as septic shock, cardiac arrest and hemorrhagic shock, acute toxic ingestions, acute myocardial infarction, and stroke. Emergency medicine has the science of resuscitation at its foundation and emergency medicine physicians directing basic science in this fundamental field of knowledge will be critical to developing patient-directed outcomes in the 21st century. In addition, there is increasing recognition that the time-sensitivity of diagnosis and treatment for acutely presenting diseases require basic science models of disease that can give us better markers and potential targets that determine decompensation versus resolution of acute disease. Without these basic insights, it will be difficult to develop the best clinical trials of the future. Key issues facing the emergency physician interested in developing a basic science program of study are mentorship, area of study, model selection or development, resource identification/acquisition, and funding (Table 5-1).

TABLE 5-1.

Keys to Success in Basic Research Emergency Care Research

MENTORSHIP	STUDY AREA	DISEASE MODELS	REQUIRED RESOURCES	FUNDING	TIPS TO SUCCESS
Personality fit	Interests	Cellular	Time	NIH	Enthusiasm
Experience level	Background	Tissue	Research technician	Private foundations	Innovation
Publication record	Synergy with mentor and institutional priorities	Animal	Lab space	Industry	Expand horizons
Trainee history		Biochemical	Equipment	Intramural	Avoid PAIDS
Funding			Animals	Private donations	Differentiate
Availability					Focus
					Collaborate

MENTORSHIP

To most aspiring investigators, defining their area of study (i.e., the question) and the mechanics of developing a research project around that question are their greatest challenge and opportunity. As a first step, the most fundamental issue facing the new investigator is finding appropriate mentorship. This is especially true for those interested in basic science research. Although mentorship has been discussed in previous chapters, the importance of finding someone who can provide encouragement, advice, and instruction in the basic sciences cannot be emphasized enough. The decision to pursue a basic science research project is not unlike beginning a new competitive athletic sport. To be successful, the beginner will require a coach or personal trainer to help them formulate goals and strategies to achieve them. Although the pool of emergency physicians may be smaller than other specialties, it is possible to find excellent mentors. How does one begin to find the appropriate mentor?

A good place to start can be a department chair, director of research, program director, or senior faculty member who is familiar with other programs and investigators in emergency medicine. These individuals tend to be more familiar with other programs and investigators in emergency medicine. Establishment of an early career mentor for an aspiring investigator is important not only for gaining advice and guidance but can open doors to additional mentors who may have greater interest or expertise in the field of interest. Multiple mentors may be necessary to gain technical expertise and specialized advice. Finding the right mentor is a trial and error process and may take time. Some mentors may be adequate in certain areas and times in an investigator's career. Other avenues for finding appropriate mentors are national meetings, research forums, and interactions with other laboratory groups. The new investigator should also be willing to seek mentors outside of emergency medicine. The SAEM career guide found at the SAEM web site *http://issuu.com/saemonline/docs/emergency-medicine-academic-career-guide* is an additional resource.

Personality fit should always be considered. Is the mentor someone you respect and has similar values to you? What are their views on life balance and family commitments? Good mentorship is found when both the mentor and mentee benefit from the relationship

and find growth and satisfaction from that relationship. Potential mentors should also be evaluated on their level of experience, publication record, trainee history, level of funding, and schedule availability to trainees. The mentor's level of experience will be important in gaining access to collaborators within and outside the institution, receiving invited publication and speaking opportunities, as well as access to resources. The mentor's publication record should also be evaluated to determine their level of productivity and ability to bring projects to closure. In addition, how well has the mentor done with trainees in the past? What was the background of their trainees, what was the measurement of their success, and where are they now? The mentor's history of trainee success is a strong indicator of quality mentorship. Basic science research is resource intensive and the mentor's funding level is important in that it will determine the level of stability of the research over the course of the mentorship. A mentor whose funding is about to expire could lead to instability in the lab, resulting in delay of research progress. Institutional investment in mentor's science (i.e., internal funding, endowments, development support) is also an important indicator of funding stability. Another important mentor feature is schedule availability for regular meetings with the mentee. Will the mentor be able to meet daily or weekly with the mentee to discuss ideas and research progress? Successful mentorship requires time and presence.

In summary, choosing a mentor is the most important decision of the research process. Successful mentorship is a predictor of future academic and scientific success and should be approached with the most careful of consideration (4). It is imperative that the investigator can have open and honest discussions with the mentor. The personalities of the individuals involved will be important in the success or failure of such a partnership. Mentorship should be recognized as an evolutionary process that will change with the career phase and needs of the mentee and the mentor. Great mentorship has the possibility of evolving into a lifelong friendship that benefits both the mentor and mentee.

AREA OF STUDY

Deciding on an area of research focus is the other crucial decision for the new investigator, and is a decision that often occurs concurrently with the choice of mentor(s). In emergency medicine, basic science research has concentrated in a few key areas including infection (sepsis/septic shock), respiratory/allergy, cardiac resuscitation, hemorrhagic/hypotension/ischemia-reperfusion, lung injury, and aging (geriatrics) (3). Selection of a study area is guided by the investigators interest and background, but may require compromise depending on the priorities of the mentor and the trainee's institution. The new investigator should read extensively in their area of interest and meet with potential mentors to discuss possible research topics. Selection of a research area is often inseparable from the mentorship search since the new investigator will often be working on projects closely related to the mentor's expertise. Another factor should be the mentees previous background and skills set. Does the mentee have previous experience in the chosen field? Often it makes sense to build on prior strengths. Finally there must be synergy between the mentee, the mentor and the institution for the chosen research area. The reason for synergy between mentee and mentor has been mentioned but institutional support is important as well. If the institution lacks collaborators or shared equipment facilities, or leadership support for the chosen research field, success will be more difficult.

Finding the needed expertise and resources may require help from your department or division to find investigators with similar interests at your institution outside of emergency medicine. The SAEM career development guide online offers additional advice on formulating the research question and can be found online at *http://issuu.com/saemonline/docs/emergency-medicine-academic-career-guide*.

MODEL AND MODEL DEVELOPMENT

Once mentorship and an area of study have been selected, the new investigator is ready to begin the "business of science." To study pathophysiological concepts of disease, scientists often use biochemical, cellular, tissue, and animal models. This is often necessitated by the inability to study these mechanisms in human patients or the lack of available human subjects or tissue. Reactions between purified enzymes or proteins are used to model biochemical reactions inside cells or the circulation. Cellular models are also used to understand how environmental changes affect cells within a tissue. For example, isolated cardiac myocytes exposed to defined ischemic conditions in a perfusion system can recreate the conditions of cardiac arrest and myocardial infarction at the cellular level to better understand contractile, biochemical, and molecular changes. Animal models are then used to further verify and test concepts learned from cellular and biochemical models.

An important caveat to the use of biochemical, cellular, and animal models is that they are somewhat artificial in nature and may not entirely reflect the desired human pathology entirely. This concern usually means that multiple studies must be performed to validate the model or establish it as an acceptable approach to study the disease of interest. These studies can be time consuming and the new investigator is wise to use already established models of disease. However, the use of biochemical, cellular, and animal models in one's research can produce a robust well-rounded research approach that leads to more mechanistic insights than using one model in isolation. Synergistic findings between the uses of multiple models will produce convincing evidence of a physiological event and help guide clinical trials that are likely to be successful.

NEEDED RESOURCES

Time

Basic science research is intensive in its need for time, laboratory space, equipment, and personal resources. Foremost among these is time. Successful investigators typically devote a minimum of 75% of their time to their research. The most important and fundamental need of the new investigator is protected time from clinical duties and obligations. Some sections or departments may be willing to provide initial protected time, but these instances are exceedingly rare. In most instances, department or section chairs expect new faculty to "buy down" their clinical time with internal or external grants. This makes career development difficult for the new investigator because many institutions such as the NIH or private foundations are unwilling to give grants unless the investigator already has protected time or ample preliminary data (which is impossible to obtain without protected time). In many specialties, the solution has been to utilize research fellowships, which give the new investigator several years of secured protected time to develop their research publication portfolio and to apply for NIH or private research funding. At the end of the fellowship, the new investigator can then apply for an academic job with future funding likely.

Research technician

It is unrealistic to expect that the physician scientist will spend 100% of his or her time in the lab. However to be competitive, research requires 100% of effort. To achieve this, a physician scientist will eventually need a laboratory technician to help carry out the needed experiments.

Lab space/equipment/animals

The junior investigator will also need to have laboratory space and necessary equipment. The investigator's mentor may initially provide this space. In return for space, equipment, and laboratory support, the mentor will have an investigator leading the publication of some articles they will be part of. Collaborations will need to be sought out to obtain

supplies or equipment not in the labs. Animal costs can be significant and require good planning and budget review. In addition to financial costs, time will be required to ensure adherence to animal care protocols and timely completion of required forms.

FUNDING

Finally, successful basic science research requires adequate funding to support the necessary resources to be successful as alluded to in the preceding sections. There are many potential sources for establishing funding. In the competitive research environment, the new investigator will have to perform a rigorous search of these funding opportunities. The largest and most obvious source of basic science funding is the federal government through agencies at the NIH and the National Science Foundation (NSF). Federal funding opportunities may also exist through other agencies at the Department of Defense. Private foundations also fund research in defined areas. As examples, the American Heart Association provides new investigator funding for cardiovascular research while the Ellison Medical Foundation provides funding for research in aging-related pathologies. For emergency physicians in particular, the Emergency Medicine Foundation funds new investigators. In addition, private industry such as pharmaceutical companies and medical device manufactures can be queried regarding funding opportunities. Funding opportunities or initiatives may also be available within one's institution and should be explored through one's department administrators. Finally, the solicitation of donations from patients, friends, and relatives can also be sought.

There are many funding mechanisms through these agencies which have been listed in prior reviews (6). Grant writing is a skills set of its own and is discussed in more detail elsewhere (7). Funding through the NIH and/or the NSF however is regarded as the hallmarks of the successful investigator. Despite the many opportunities for funding, competition is fierce and the new investigator will need the full support of his or her mentor, department, and institution to be successful.

TIPS TO SUCCESS

The key components of success in basic science research include mentorship, a defined area of study, the use of relevant disease models, and appropriating the necessary resources, time, and funding for training and generation of preliminary data. Overall, there are seven general principles that the new investigator should follow in order to be successful.

1. *Enthusiasm:* Enthusiasm for your research will enhance the morale of your lab and increase your commitment to completing projects. It will also act to help "sell" your ideas to friends and colleagues. If you do not display enthusiasm regarding your research it will be hard to get others excited about your work. Enthusiasm may also be an important indicator of the potential impact you believe your research question will have on current practice, and thus whether you are focusing on the best question.
2. *Innovation:* A second principle to be adhered to is innovation (5). Is the research being done likely to change current concepts of a disease or improve the human condition? Is the research significantly different from others in the field? If not, is the research significant and is it worth doing?
3. *Attend lectures or seminars outside your field:* Often new techniques or scientific concepts develop in fields unrelated to yours but may offer avenues for producing new insights and discoveries. Broadening your horizons outside of your particular area of focus can help avoid tunnel vision and facilitate innovative thinking and novel approaches.
4. *Avoid PAIDS* (paralyzed academic investigator's disease syndrome) (5). The idea of PAIDS was first discussed by Nobel laureate Joseph Goldstein describing a condition of some

investigators when their work leads them to a new critical challenge outside of their comfort zone, such as a factor that needs to be purified or a new gene that needs to be cloned. However, rather than tackling these new challenges they move laterally to easier pursuits. When investigating a topic, do not be afraid to learn new techniques or invest necessary energy into critical but difficult projects. They are often the most rewarding.

5. *Differentiate yourself from your mentor:* While pursuing research with your mentor, be on the lookout for projects or ideas that will distinguish your work from your mentor's. This will be an important consideration as you pursue independent funding and faculty promotion.
6. *Focus:* Peter Rosen once said, "Pick a topic and focus on it." This axiom is as true for life as it is true for success in academic emergency medicine. The new investigator should begin with one or two clearly defined research projects with reasonable objectives. As you progress in your career, your colleagues should be able to easily identify your focus by the common themes of your lectures and publications. Becoming distracted by other research projects can result in decreased productivity and lack of research focus.
7. *Collaboration:* Given the increasing complexity of basic science research, it will become critical for future success to identify mutually beneficial collaborations with research partners. Identifying existing program project grants at your own institution or elsewhere in your field can help conceptualize potential collaborations between basic science laboratories.

Additional rules such as those above regarding the approach to research are nicely summarized in the ten commandments of research by Kahn et al. (5).

CONCLUSIONS

In this review, we have identified the five key aspects of basic science research in emergency medicine: mentorship, area of study, model selection/development, resources, and funding. Of these, mentorship is the most important. The history of academic medical science is built on successful collaborations and research partnerships. Mentorship is the critical initial foundation for this academic success. Successful mentorship will likely guide the junior investigator in handling all other aspects of basic science research. Here we have highlighted other aspects of a successful research program and other potential sources for reading on these topics (8). In addition, principles for a successful career have been listed. Participation in basic science research holds great promise to further develop our medical specialty. Novel diagnostic and clinical strategies for time-sensitive emergency treatment will be developed more rapidly through discoveries in the laboratory. Thus, a basic science research career holds tremendous promise for improving the lives of many patients well beyond our own clinical work.

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TRAINEES AND EMERGENCY CARE RESEARCH

Heemun Kwok, MD, MS

Roger J. Lewis, MD, PhD, FACEP

INTRODUCTION

The training of an academic emergency physician typically occurs in three steps — medical school, emergency medicine residency, and fellowship training — with substantial increases in medical knowledge and experience occurring at each stage. It is both natural and appropriate for the acquisition of clinical knowledge and skills to be a trainee's primary goal during medical school and residency; further, research activities should not be allowed to compromise the medical education of future independent practitioners. While academic and research skills and experience can be gained at all stages of training and, in fact, are a major emphasis in some specialized training models (e.g., the MD/PhD training model exemplified by the Medical Scientist Training Program funded by the National Institute of General Medical Sciences of the NIH [1]), it is most common for the acquisition of substantive research skills to occur during fellowship training. Nonetheless, research experience during medical school and residency can provide the trainee with important skills and perspective, and help the trainee to evaluate future potential career paths.

The intended audience of this chapter is those in clinical training programs (e.g., students obtaining an MD without additional degrees, residents, and clinical fellows). A large majority of the material in the other chapters is relevant regardless of one's career stage, so this chapter will focus on issues in research that are specific to trainees. There are many considerations related to the identification of a faculty mentor and the design of a trainee's research experience, so these topics comprise the largest part of this chapter. Execution of the research project and options for formal training in research methodology will also be discussed.

IDENTIFICATION OF A FACULTY MENTOR AND DESIGN OF A RESEARCH EXPERIENCE

Medical students

Research can be a valuable addition to the didactic and clinical activities that comprise the bulk of medical education. Despite their relative clinical inexperience, students can contribute significantly to an investigation, and even serve as the lead investigator of a suitably chosen study. There is a wide spectrum of student research experiences, but they can generally be categorized into two types. In the first category, the student's primary role is to assist with data collection in the clinical research setting. Typical activities include enrolling research subjects in the ED, conducting chart reviews, and performing follow-up for one or more ongoing studies. Students are not necessarily involved in other aspects of the research process, such as study design, analysis, and dissemination of findings, although there are may be opportunities to do so. The expected time commitment can be established clearly, since the quantity of work can usually be defined by some measure (e.g., hours spent in the ED capturing eligible research subjects or number of charts reviewed). Exposure to the clinical and research environments of emergency medicine is valuable for many students, particularly preclinical students. They have an opportunity to work closely with faculty members and identify potential mentors, who can play an important role as students negotiate undergraduate medical education and their transition to residency.

However, data collection is arguably the most tedious and least enjoyable aspect of research, and students who are sufficiently motivated may wish to consider a broader research experience with greater autonomy. An independent project typically offers an opportunity to work more closely with a mentor over a longer period of time, to acquire a wider spectrum of research skills, and to experience the intellectual challenges of research. Of course, the student is also more likely to experience the frustrations of research, so this type of project requires greater motivation and commitment. Therefore, students must have a realistic idea of the time that they will be able to dedicate. At a minimum, an independent research project requires three months of dedicated time with additional time during evenings and weekends while on other rotations. Taking a 1-year leave of absence in the middle of medical school to conduct research is an option but is often inadvisable for academic reasons alone, since a year focused on research after one obtains a medical degree will usually provide higher yield. However, we have seen this approach work very well for selected and motivated students. We caution against students undertaking this type of project without having both a strong interest in a research career and sufficient time to devote, because, despite the best of intentions, untold student research projects are never completed, or ultimately require completion by faculty mentors, a situation that may not reflect well on the student.

If a student decides to commit to an independent research project, the first step is to identify a suitable mentor. While students should consider their subject area interests, it is more important that they find a suitable and willing faculty mentor to play a formative role in the overall research experience. Therefore, a student should be flexible with regards to subject matter and not underestimate the importance of a mentor who is able to understand the needs of the student (2). The resources that are available to assist with identifying mentors vary according to institution, so we restrict ourselves to a few general comments. Availability and a track record of working successfully with students are more important than the potential mentor's number of publications or national reputation. Of course, an extensive research portfolio never hurts, and the mentor should be involved in enough projects so that he or she can provide an experience that matches the strengths and objectives of the student. After a mentor has been identified, the student and mentor

can jointly identify a research question and design a suitable study. Because this process will be similar for students and residents, we will defer considerations related to study selection until the next section.

Residents

Residents may consider conducting research during residency for a number of reasons, such as to fulfill a residency requirement, to inform a decision regarding future career direction, or to prepare for a future academic career. The value of a resident research requirement is debatable (3, 4), but generally speaking, an activity that is primarily externally motivated is less likely to result in lasting benefit for either the resident or faculty mentor. Other types of scholarly activities, such as authoring book chapters or clinical review articles, may provide a more valuable educational experience in this circumstance. In the second situation, residents who are trying to decide between community-based and academic careers should be cautious about placing undue weight on a single research experience, because it may result in the premature abandonment of a potential academic career. It can be misleading to compare the immediate satisfaction of clinical practice, such as the making of a challenging diagnosis, a touching patient encounter, or mastery of a procedure, with that of research, which can be a solitary pursuit with delayed gratification. A better predictor of long-term career satisfaction may be to compare the gratification from caring for patients with routine presentations, such as nonspecific abdominal pain, viral bronchitis and the like, with the intellectual stimulation derived from research activities.

Regardless of the motivation for pursuing research, residents should select mentors and study questions that are aligned with their objectives. Residents should attempt to define a question based on their own clinical experiences, because the process of conceiving a testable question and developing an appropriate design is educational in its own right, even if the study is never executed. Identifying an answerable question is a challenging task, even for experienced investigators, and the resident should not hesitate to speak with mentors about potential research ideas (5). The most important criterion for a resident or student project is feasibility within the allotted time period. It is better to successfully complete a study that addresses a simple question than to undertake a more ambitious study that is never completed. Prospective data collection is possible if planning is initiated early during the residency, but a retrospective study is often a more reasonable option; even a study that involves the retrospective collection of data usually requires more time than anticipated. If there is an existing dataset that can answer the study question in a valid manner, then analyzing these data can be an efficient approach, because it allows the resident to focus their energy on aspects of research other than data collection. Residents often spend the greatest proportion of their time on data collection at the expense of other activities, such as data analysis and manuscript preparation. These other activities have greater educational value and, if the resident is considering a future academic career, they reflect more accurately the duties of more established academic researchers.

Fellows

Fellowship provides an opportunity for graduates of emergency medicine residency programs to develop an area of specialized expertise, with the majority of fellows choosing to focus on clinical areas, such as pediatrics or ultrasound. For fellows intending to ultimately practice in a community setting, considerations regarding the selection of a project are similar to those for residents discussed previously. Often, however, fellowship is a stepping stone towards an academic career that will involve research activities to some degree. In this circumstance, work on more ambitious individual or even ongoing collaborative projects during fellowship should be considered, especially if that work can reasonably be expected to continue after graduation from the fellowship. For example,

the fellow may continue to work on the project as a faculty member at his or her current institution after the completion of training or may continue collaboratively after taking a position at another institution. An extended time horizon and working collaboratively provides greater flexibility in the questions that can be asked and the types of study designs that can be considered.

It is generally more educational and valuable for a fellow who anticipates research being a substantial component of his or her future career to complete a single project for which they have ownership, from start to finish, within the span of their fellowship. Doing so will, of course, require that the complexity and scope of the project be reasonable relative to the fellow's available time and expertise. The fellow should consider the tradeoff between conducting a study with greater methodological quality (e.g., a prospective design versus a retrospective design), and/or power and one that can be completed more rapidly and reliably. A frustrating research experience can adversely affect a trainee's long-term interest in research, and generating a publication track record is particularly important early in one's career, as it can establish one's potential for success as a researcher and improve competitiveness for employment and grant funding.

For a fellow participating in a dedicated research fellowship, as opposed to a clinically-focused one, it is critical that he or she devote the majority of his or her efforts towards the completion of a project that is primarily his or hers. In other words, the primary focus should be on a project for which he or she is the unequivocal principal investigator and thus responsible for all phases of the research — definition of the study objectives, obtaining institutional and IRB approvals, data collection, data analysis, manuscript preparation, and interaction with the peer review system. For this primary project, it must be feasible for the fellow to complete the project and draft the primary manuscript within the duration of the fellowship. Taking a single project from conception to completion ensures the fellow understands the entire arc of the research process and, just as importantly, provides a tangible example of the fellow's intellectual work product. Prospective employers may, appropriately, consider the success and quality of the fellow's primary project as an indicator of the likelihood of success in subsequent research endeavors.

PROJECT EXECUTION

After a tentative research question is identified, a detailed timeline should be established. The timeline can help provide a final assessment of the project's feasibility and ensure that the trainee's clinical and other educational activities will not be compromised. The timeline will also be useful as a benchmark to gauge progress throughout the study. As explained next, the timeline should include time allocated for manuscript preparation at both the beginning and the end.

Before any data are collected or analyzed, the trainee should perform a literature search and write as much of the manuscript as possible. A draft of the introduction, methods, a portion of the discussion, and skeletons of tables and figures can often be produced in advance. In addition to increasing the likelihood of eventual publication, this exercise has three other purposes. First, it ensures that the trainee finds the research question to be engaging enough that his or her interest will be maintained throughout the duration of the project. Second, it demonstrates a level of commitment that justifies a reciprocal degree of commitment from the faculty mentor. Third, and most importantly, it will result in a higher-quality study. By thinking critically from introduction to conclusion, the trainee will develop a better understanding of the project in its entirety, make improvements to the study design, and more efficiently execute the project. For example, after writing the methods section, most likely in collaboration with a statistician, the trainee will be better positioned to collect data accurately and efficiently. Not infrequently, during the statistical

analysis phase of the project, long after the data collection has been completed, it becomes apparent that a crucial variable is either missing from the dataset or coded incorrectly. To protect against this undesirable eventuality, some researchers collect data on many more variables than could possibly be employed in the analysis, which is both inefficient and increases the potential for errors. Creating skeleton tables and figures can help ensure all necessary variables are collected, while helping the trainee to focus data collection efforts on only those data elements that are required.

Unfortunately, thorough preparation is no guarantee that a study will be successfully completed. Anticipated and unanticipated setbacks are inevitable and often times beyond the control of investigators. Bench experiments may fail for one reason or another, animals may not survive, eligible subjects might not be reliably identified, or a dataset may turn out to be unavailable. In some cases, an oversight committee, such as an IRB for human subjects research or an animal care and use committee (ACUC) for animal research, may request that a protocol be modified or require additional information. Determining how best to negotiate hurdles is part of the learning process, and an experienced mentor can be extremely helpful in this regard. Successful completion of a study requires substantial persistence and an element of luck.

A project that does not result in publication, or at least submission, of a manuscript arguably fails to accomplish the primary objectives of a trainee research experience, which are to acquire research-related skills and, similar to any other research project, to improve the emergency care provided to patients. Of all the skills required to be successful as a researcher, the ability to write well is perhaps the most important. All researchers, regardless of seniority, spend a considerable amount of time writing, in contrast to other activities, such as data analysis and data collection. Therefore, completing a manuscript should be given the highest priority and sufficient time should be allocated to writing, review, and editing. In reality, researchers at all levels often find it difficult to sequester time for writing, despite its critical role in academics and research. Unfortunately, it is not uncommon for a trainee to complete the data collection and analysis, only to fail to disseminate the results, except, perhaps, as a conference abstract. This trap must be avoided if at all possible.

FORMAL RESEARCH TRAINING

The basic instruction in statistics and study design that is included in undergraduate and graduate medical education curricula is far from adequate preparation for the independent conduct of research. Most trainees will need to collaborate with someone who has statistical expertise to assist with study design and data analysis. A suitably motivated clinician can learn a substantial amount of statistics through interactions with statistical colleagues, self-study, and other informal means. However, formalized education can expedite and solidify this learning process for those who are so inclined. Many institutions offer short courses in biostatistics, epidemiology, and other research-related skills for clinician investigators. While not intended or sufficient to prepare clinicians to perform research independently, they can help clinicians to have a better understanding of statistical issues.

Advanced degree programs are another option, but even master's programs require a time commitment of 1 to 2 years. Many institutions offer training in research methodology for health professionals that leads to a master of science in clinical research (MSCR) degree. These programs are intended for residents, fellows, and junior faculty interested in independent careers in clinical research and can often be completed while maintaining some clinical duties. Another option is a traditional program, such as a master of science (MS) or master of public health (MPH) in epidemiology or biostatistics. Participation in an advanced degree program can be integrated into any fellowship program, but within emergency

medicine, it is most consistently incorporated into dedicated research fellowships. Properly structured research fellowships incorporate substantial time for the trainee to focus on methodological issues and develop statistical expertise. They can remove years from the slow learning curve associated with the acquisition of research-related skills and are recommended for those who wish to pursue an independent research career.

CONCLUSIONS

Research experience can be a valuable addition to one's clinical training. Trainees should align their research experience with their short- and long-term career objectives and be realistic regarding the amount of time that they can commit to their project. Mentorship is particularly important when conducting research during training, and trainees should work closely with faculty mentors in all aspects of research. Formal courses in research methodology can accelerate the acquisition of research-related skills, and obtaining an advanced research degree is strongly encouraged for those who aspire to be independent researchers.

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PRESENTING THE RESULTS OF RESEARCH

Debra Houry, MD, MPH. FACEP

HOW TO WRITE A COMPELLING ABSTRACT

The best way to ensure a high-quality abstract is to conduct a high-quality study. The other chapters in this book will help you identify mentors and develop research protocols, so that will not be the focus of this chapter. However, there are some methods to ensure that your abstract is presented in the most effective and compelling manner.

Abstracts are usually about 250 to 300 words, although this depends on the meeting to which you are submitting it. Use structured headings including Objective, Methods, Results, and Conclusion and make sure you follow the instructions exactly regarding word count and use of charts and symbols. When putting together your abstract, consider that the average reviewer for most emergency medicine meetings has approximately 50 abstracts to review. Thus, if something is not immediately clear in your abstract, it is unlikely that the reviewer is going to spend time trying to sort out the information in the abstract. Consider whether you need an introduction section. Introduction sections are not always necessary but can be helpful to frame your research for the reviewer and reader. On the other hand, a common mistake is to have a long introduction with very little methods and results. Reviewers focus on the validity and reliability of the study and this cannot be determined if the methods section is sparse. The next four paragraphs outline tips for each section of the abstract, and Table 7-1 summarizes the key points.

The objective should be no more than one or two sentences and the research question must be clearly defined. For example "Our objective was to screen women in the emergency department to see what they come in with" is rather broad. A more focused objective might be "Our objective was to identify specific characteristics on the history and physical exam for women in violent relationships who present to the emergency department. We hypothesized that victims would be twice as likely to present with mental health symptoms and facial injuries than other female patients."

With regard to methods, it is important to include as much information as possible so the reviewers know the study was conducted in the most stringent manner. A retrospective chart review study should include information on training of reviewers, use of standardized

TABLE 7-1.

Key Points for Abstract

Objectives	Should be very defined Include hypothesis
Methods	Type of study design Inclusion/exclusion criteria Measures of validity (research assistant training, sampling method, blinding) Measures of reliability (interrater reliability, validated scales, power calculation) Statistical testing
Results	General information on population studied Results specific to your objective/hypothesis Include p-values and confidence intervals when appropriate
Conclusion	Brief statement regarding findings related to the objective

abstraction form, and interrater reliability (1). A survey study should use validated scales and representative sampling. A clinical trial should follow CONSORT criteria and include information on randomization, blinding, and sample size (2).

Similar to the methods section, the results section must include standard information pertinent to the study. First, start off with baseline characteristics of the study population. For a survey this includes the response rate and any demographic data that were collected. Chart review studies must list how many charts met criteria to be pulled, how many were found, and how many had missing or incomplete data. Prospective studies should parallel enrollment: how many patients were approached, how many were eligible, and how many consented. When possible include information on differences between those who refused or were excluded compared to the final study sample. Another common mistake authors make is to include every significant finding from their study. The results section mirrors the objectives listed in the abstract and additional findings can be ancillary and distracting.

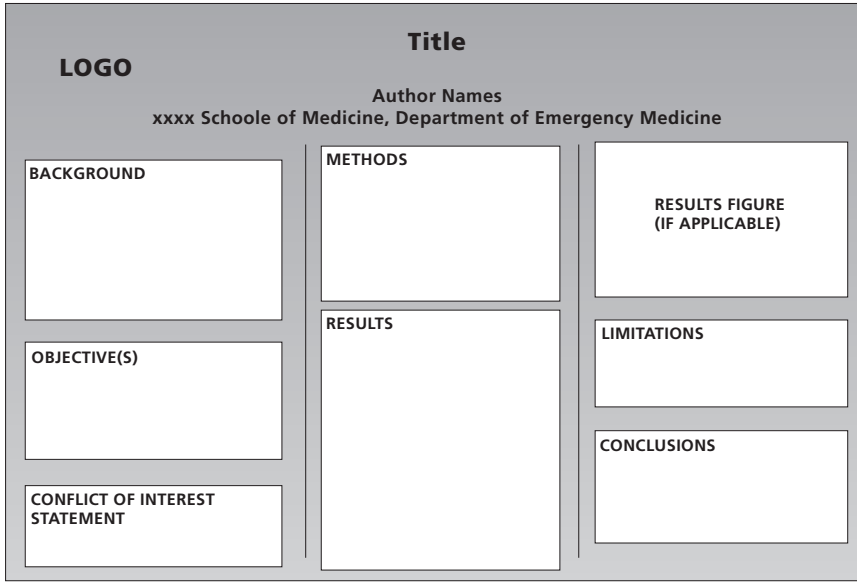
The conclusion section should in one or two sentences summarize whether the hypothesis was supported. This section should not be used to talk about future studies or to assert one's opinion. Again, it is important to remember that you do not know who might be reviewing your abstract so it is best to be as neutral as possible and not to overstate your findings.

HOW TO CREATE AN INTERESTING RESEARCH POSTER

Poster presentations are an excellent opportunity to present your work, meet other researchers with similar interests, and to get feedback on your work. The format of poster presentations depends on the scientific meeting ranging from standing in front of your poster during designated time slots, giving a brief 3- to 5-minute overview of your work as part of a tour of posters, or giving a brief presentation alongside two or three similar posters with time for discussion at the end. Despite the format of the presentation, the poster layout itself does not vary. See Figure 7-1 for a poster template.

FIGURE 7-1.

Poster template example.



The information on the poster mirrors what was in the abstract, but in more detail. However, this should not be as detailed as a full manuscript as people will not have the time to read that much detail. Bullet points are particularly helpful for results and methods so the general information on how the study was conducted and what was found can be easily identified and read by others. Text on posters should be in at least 36 font so that people can read the posters from several feet away.

Because many people will spend just a few minutes at your poster, it is helpful to have a brief script prepared to provide the highlights of your study. If you are presenting as part of a moderated session, this script should be no longer than 5 minutes. The focus of these presentations should be on the "why" (the study objective and hypothesis), a brief "how" (what you did), and your relevant findings. Further discussion on next steps and limitations may also be warranted.

HOW TO PREPARE AN ENGAGING ORAL PRESENTATION

Scientific presentations should be focused on the research and follow a logical flow similar to the abstract subheadings. The slides help you relay your information but should not detract from your talk.

A few simple rules to follow in preparing your slides:

1. Do not use animation or sound — this is distracting and takes away from the content.

2. Use bullet points — no more than five words a line and no more than four lines a slide (three is preferable).

3. Font should be a minimum of 20 point with larger fonts for main points and headings.

4. Make sure colors are readable — use dark colors for words and figures (black or blue) on white backgrounds and light colors (preferably white) on darker backgrounds.

The oral presentation format is usually 10 minutes for the presentation with a 5-minute period for questions. The time limit is strict and if you go over the allotted time, you will not be allowed to finish your presentation so practice the presentation and time it many times before the actual meeting. A total of 15 slides should be sufficient.

A brief personal introduction is fine ("Good afternoon, I'm Deb Houry from Emory University and I'd like to present our project on xxxx"). The first slide should list the title, your name and coauthors, and institutions. You should not read out loud each coauthor's name. A general acknowledgment of the collaborative effort is sufficient. The second slide should disclose any conflicts of interest, and many societies have a specific format to use for this.

Background information should include no more than two or three slides. It is good to mention BRIEFLY what has been done before, but this should not be an elaborate literature review as many people in the audience will be familiar with this research.

The methods section should follow a format parallel to how the study was conducted—what were enrollment criteria, who approached patients, and what was the study flow. Psychometrics on specific instruments should be briefly mentioned when available.

When possible, use graphics to highlight results instead of words. Progress from general information: demographics, response rate, eligible patients, etc. to specific results that are relevant to the study hypothesis.

Finally, wrap up the presentation with one slide on limitations and future studies followed by the conclusion slide. Do not end with limitations as this is not what you want the audience to walk away remembering. End with a conclusion slide with two or three succinct points summarizing your study results.

CONCLUSIONS

Presenting your research in abstract format is an exciting first step but should not be the final step in your project. After the presentation you can incorporate feedback from meeting attendees into your manuscript and submit your work to a peer-reviewed journal.

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BASICS OF SCIENTIFIC GRANT WRITING

John G. Younger, MD, MS

THE IMPORTANCE OF RESEARCH FUNDING TO YOUR CAREER

All research costs money. Any suggestion to the contrary stems from incomplete accounting of the effort and resources needed to accomplish the work. Accordingly, an unavoidable feature of doing research is establishing a means by which to monetarily support it. At its least formal, this support may involve an investigator spending their own time or unstructured effort within their academic appointment to carry out a project. Such efforts typically require no written budget and no record keeping. The work is not free—the time spent could be spent doing something else with either one's personal time or the time for which one is being paid — but avoids any formal planning for funding. At its most complex, research support may involve tens of millions of dollars over several years with detailed federal budgetary oversight. Fortunately, the complexity of research funding typically evolves apace with the sophistication of one's research program, such that young investigators usually work with relatively modest budgets and minor administrative headaches. As a scientist at the beginning of your career, it is not important for you to understand the nuances of countless funding mechanisms. Rather, it is most essential to internalize the necessary link between research and money and to develop a sense for why it is that organizations are giving money away and how best to successfully receive that gift.

Most research funding is allocated on the basis of some type of peer review and is inherently a competition. From this fact flow two additional realities of grant writing. First, an awarded grant is an acknowledgment of you, your ideas, your past performance, and your promise. Awarded grants thereby bring not only funds but also nonmonetary prestige to you, your department, and your institution and make available opportunities to which you'd otherwise not have access. The second reality is the flip side of the first: grants are received at the expense of some other investigator. Grant proposals that you write must not only be good ideas skillfully proposed, but must be superior to others being simultaneously considered. Grant offerings are a call to compete. Someone will win and someone will lose. It is not necessary, nor is it likely, to win every time. It is necessary to win often enough to accomplish the work one has planned.

Much of the objective success of your research career will proceed from your ability to acquire and intelligently spend grant funding. The rest of this chapter is meant to introduce you to the most basic features of grantsmanship and it is hoped that with this discussion will come funding success for your work. However, before going any further three points should be emphasized.

First, this chapter will not discuss the design of scientific work (e.g., hypothesis generation, measurement methods, statistical analysis). Learning how to do science is distinct from learning how to write grant proposals.

Second, for grant writers needing to learn what constitutes a strong proposal, there is no substitute to having access to other individuals' successful and unsuccessful grants. If you want to learn how to write a good grant, read a lot of other peoples' applications. Many seasoned scientists will comment that the most important improvements in their own grant writing skill came when they were invited to become reviewers of other investigators' applications. Likewise, as you become more established as an investigator, you should make a point to share your good and bad writing experiences with more junior scientists.

Thirdly, it must be remembered that many of the most personally important benchmarks of success in one's research career — discovery, collaboration, mentorship — transcend funding. Perspective, particularly the evening after one of your grants is rejected, is key.

TYPES OF GRANTS

Why do organizations offer grants? There are a few common motivations that move departments, schools, foundations, and governments to offer money for research. The most intuitive is an organization's need to better understand a particular problem or to develop or evaluate a solution to that problem. Grants offered in this spirit are often referred to as "requests for applications (RFAs)" and usually focus tightly on a particular issue. For example, the Emergency Medicine Foundation frequently will sponsor a grant directed at a particular problem in the specialty, such as ED crowding. The upside of RFAs is that occasionally a funding agency will post one that is an obvious fit to your area of expertise. However, unless the RFA specifically requests applications from junior investigators, scientists early in their career are unlikely to nab such targeted grants as usually dozens of other investigators, many with greater resources and experience, will join in the competition. In general, I believe it is a mistake for junior faculty to chase calls for specific research unless protections are in place by the sponsor to favor junior investigators.

The other major category of award is often referred to as "investigator initiated." In this instance, rather than announcing what it believes to be important, the funding body leaves it to applicants to reveal what problems warrant funding and specifically what work needs to be done. Arguably this 'bottom up' approach is at the heart of the long-term success of the US biomedical research enterprise. This mechanism proceeds from the assumption that researchers, not funding agencies, are better judges of the gaps in knowledge that need to be filled. For applications such as these, it is incumbent on the investigator to not only propose good science but also make a powerful argument for why the problem is significant enough to receive funding. Most of the grants you write in your career will be of this type.

A very important category of grant you will encounter early in your role as a scientist is a career development grant. These grants, which may be directed to students, residents, fellows, junior faculty, or even senior faculty, are specifically intended to support advanced training. This training may be formal, as in pursuit of an advanced degree, or less so, such as dedicated time away from other duties to learn a new technique. Training grants may take the form of a targeted-issue, RFA-type grant, such as a training grant for junior investigators studying the pathogenesis of shock. More often, the topic to be studied is

not prescribed, rather the funding agency relies on the applicant to pursue a problem of importance and interest. Departmental or institutional seed money grants often are fundamentally career development grants. Essential to training grants is not only a solid scientific proposal but also a well-conceived educational plan that identifies and meaningfully addresses your educational and experiential shortcomings.

TYPES OF SPONSORS

For many in biomedical research, the term "sponsor" is all but synonymous with the NIH. In 2010 the NIH budget was approximately $31 billion, making it by far the largest supporter of biomedical research in the world. For investigators hoping to make research the main focus of their academic career, there are few other sources of funding that are capable of fully supporting the work to be done. However, as a new investigator it is improbable your first grant experience will be with the NIH, and throughout your career you will work with many types of research sponsors.

The first you are likely to encounter is your department chair, or perhaps a research advisory committee established by your chair. Your medical school may offer pilot project funding, as may your broader university. As a source of research funding, your home institution will have a keen interest in launching your career. Nevertheless, even within this incubator, expect to encounter competition for limited funds. As of the time of this writing, it is unusual for internal sources to provide funding in excess of $20,000 or to support projects of length greater than 1 to 2 years. For those projects, one must look outside of one's institution.

Foundations are an important source of funding, particularly for new investigators and as a means of developing new ideas from established researchers. They may be specialty specific (e.g., the Emergency Medicine Foundation or Society for Academic Emergency Medicine) or disease or organ system specific (e.g., the American Heart Association). As with other funding sources, foundations may be interested in funding career development, new research ideas, or both. Commonly foundations will offer larger grants than are available within one's home institution, occasionally as large as $100,000 or more.

Last, it is common for government at all levels to provide some support for biomedical research. At the municipality or state level, funding will often be directed at a project of immediate need, such as improving medical care for indigent populations, or developing resources, such as a statewide registry for some condition. While local and state funds may occasionally support work, for most investigators the federal government ultimately becomes the source for long-term financial support. Common federal sources of research funding include the NIH, the Centers for Disease Control and Prevention, the Agency for Healthcare Research and Quality, and the Department of Defense. However, there are many more agencies that support research, and which arm ultimately supports your work will depend on where your research leads.

It is reasonable at this point to include a few comments on working with industry. Somewhat inexplicably, academic interactions with drug and device manufacturers are subject to cyclical periods of promise and disdain. While the relationship is complex and examples of poorly managed conflict of interest are easily cited, new treatments almost always penetrate clinical practice by way of a private company. Between the bench and bedside necessarily sits industry. The nature of your interactions with drug and device manufacturers will be impacted significantly by institutional norms and the type of collaborative work you are considering. Nevertheless, if you find yourself approaching a private company for assistance in completing a project, your approach toward demonstrating significance, innovation, and a feasible approach should mostly be the same as if you were approaching a non-corporate sponsor.

HOW THE REVIEW PROCESS WORKS

Success in grant writing requires understanding how your work will be reviewed and who will review it. Grant writing is unlike other technical writing, and grant review is different than other types of peer review (e.g., manuscript review) that you will encounter. It is essential to know the difference. For most of the remainder of the chapter, I will focus my discussion on the NIH review process, acknowledging that it is both far from perfect and far from universal.

A common practice among sponsors of research grants is to separate the peer review process from the funding decision process. This is the case at the NIH (which uses the Center for Scientific Review [CSR] for most scientific review) and at the Emergency Medicine Foundation (EMF) and Society for Academic Emergency Medicine (SAEM). Separating review from funding decisions removes from the reviewers the direct burden of declaring which grants will and will not be funded. It also permits the funding arm of the organization flexibility in supporting some awards that may not have the most competitive science but may meet other organizational needs. For example, Institutes within the NIH may have in place mechanisms that favor young investigators and particular areas of emphasis.

To review applications, the NIH (whose process is mimicked by many sponsors, including EMF and SAEM) convenes a *study section*, or review panel, in most cases administered by an agency called the CSR. Within the CSR, there are over 100 distinct study sections focusing on many aspects of human health. Tens of thousands of applications are reviewed each year. Study section members are a combination of investigators with broad experience in the field and researchers with deep technical experience in topics present in the applications received. The former group are *permanent* members, and the latter group are referred to as ad hoc reviewers. Many study section members previously will have had their own science reviewed by the study section on which they serve (although mechanisms are in place to review applications submitted by current study section members through an alternative process). These individuals *are not* employees of the sponsor — they are members of academia or industry who donate their time to assist in the scientific review process. 'Permanent' appointments are typically 3 to 4 years in duration, and receipt of an appointment is a substantial recognition by the scientific community of the member's ongoing contribution to their field. Permanent membership is also a large amount of work. Study sections meet three times annually, and each member will typically be responsible for 10 to 12 applications (about 1,500 pages of material) at each meeting. *It is essential as an applicant that you recognize the amount of work that your reviewers have been assigned and that you do everything possible to make your proposal an easy job.*

Foundations receive far fewer grants than the NIH and usually meet once or twice a year to review applications. Membership in these review groups is frequently driven both by investigator seniority and the desire to be as inclusive as possible within the field.

It is very important to realize that, unlikely many instances of manuscript peer review, grant reviewers are *not* blinded to the applicant. It's simply not possible, as (1) part of the determination of a proposal's feasibility is an assessment of the applicant's prior work and (2) within any field of study the community is usually sufficiently small that even if a proposal were blinded, the reviewer would readily ascertain the identity of the applicant. The implications of this extend deeply — one's reputation as a scientist and citizen of the field are unavoidably part of the grant review. Accordingly, how one's applications are reviewed may be subtly or vividly colored by interactions in other venues — applying for, reviewing, and awarding grants are ultimately, like any other interactions involving the exchange of resources, social behaviors.

There are two outputs of a study section. The first is a "priority score" or "impact score" for every application it evaluates. This list is returned to the funding arm of the sponsor which, beginning with the most competitive application, will fund "down the priority list" as far as it can before it runs out of available funds. The second product is a collection of written critiques that are returned to the applicant.

CONTACTING THE SPONSOR

The first step in applying for an application is contacting the sponsor to investigate precisely what types of applications the organization is seeking to fund. I *never* submit an application without speaking to a representative of the funding source by telephone, or if possible, in person. It is incorrect to believe that contacting the sponsor is in some way "cheating." The sponsor is ultimately interested in attracting the best proposals it can and therefore will typically communicate its desires, details of the submission and review process, etc. It will not be useful to contact a sponsor to ask, "What should I write my grant about?" Rather, the conversation should proceed from the idea you have. Discussions with the sponsor should accomplish the following:

- Provide a brief introduction of who you are, where you are in your career, and what you're working on.
- Provide a brief description of the project you have in mind.
- Determine if the sponsor believes the idea is appropriate for the funding mechanism under discussion.
- Establish the mechanism by which the grant will be reviewed and, when possible, the membership of the reviewing body.
- Glean any advice the sponsor is willing to share about the process.

WHAT CONSTITUTES A GOOD QUESTION?

Although it has been said that there are no stupid questions, there are. When writing a grant proposal, there are several features that good questions possess. First, the question must be important. For clinical questions, significance is some combination of the frequency of the condition under consideration and the magnitude of that condition's consequences when managed with current understanding. Both frequency and clinical impact must be present to some degree, as neither a very common problem with very little consequence to the health of the nation or world (e.g., how best to minimize injection discomfort with local anesthetics) nor a very rare problem of devastating consequence (e.g., perimortem cesarean section) is likely to be considered significant from a funding perspective by most reviewers. For questions in the basic sciences, significance typically involves a combination of treading truly new ground, of developing new methodologies with applicability beyond the question at hand, and likelihood of clinical impact at some point.

Second, good questions bring something new. This may be a new way of conceptualizing a problem or a new way of studying it. Innovation can also come from the combining of disciplines and collaborators in some new way. When reviewers get excited about proposals, it often is because of the innovation within the proposal. An important reason for reviewers to lose interest in a proposal is the use of ideas and methods that do not advance the field in an innovative way.

Third, the question must be appropriately scaled for the investigator's talents, the available resources, and the available budget — it must be feasible. A first time investigator will more successfully justify a single-center project with straightforward and inexpensive endpoints than a multicenter project with complex enrollment, interventions, and measurements. When a project is inappropriately large for a particular investigator,

reviewers will typically refer to the proposal as *ambitious*, which is a seemingly positive comment that actually indicates that reviewers do not believe the applicant can do what they propose.

Another hallmark of a good question is its likelihood of leading to more questions. The difference can be subtle. For example, while asking "Is *A* more effective or important than *B*," seems a reasonable aim of a proposal, a richer question might be 'In which settings is *A* better than *B*, and what patient or system characteristics predict that response?' The latter question by its design will likely collect information beyond the confines of an *A – B* comparison and is more likely to provide greater understanding of the problem at hand and suggest future refinements of the experimental question. Closely related to this concept is the idea of asking questions that will support one's career development. Proposals early in your career should include questions that open like Matryoshka dolls, where each inquiry reveals new questions on which to build your expertise.

WRITING "THE SCIENCE"

Grant applications are usually composed of two sections — the "science" and the "shell." The science portion is the portion you normally associate with grants—the aims, the methods, etc. The shell is the less visible portion — the budget, documentation of resources and institutional approval, etc. Both require time and attention to detail, and problems in either portion may be sufficient for an application to fail. A standard set of review criteria in use today include significance, innovation, approach, investigator, and environment. The first three features are captured in your science; the last two are documented primarily in your shell.

The opening science section of many applications is an element known as the "specific aims," a concise description of the entire project that encapsulates why the work needs to be done, why you should be the one to do it, and generally what you plan to do. Because the usual (and probably most effective) practice is to condense the entire description to a single page, this part of the grant is often referred to as the "aims page." This part of the proposal is analogous to the overture of an opera — in a brief interlude, all of the main themes of the proposal are touched on and anticipation is built. And, as with good overtures, at the end of a well-written specific aims page, the reader should have a strong sense of where the proposal is headed and be excited to dig into the details. If at the end of that page your reviewers are not engaged, they likely never will be. Many applications thus live or die by their aims page, and it is common for investigators to spend more time writing this one page than any other portion of the proposal. Subtleties of writing an aims page in a specific area of expertise are beyond the scope of this chapter. However, a few general points are worth making:

- It needs to include a clear statement of the problem being addressed and needs to succinctly emphasize why it is important.
- It must justify why you and your team are reasonable candidates to approach the problem.
- It should describe each of the aims of your proposal describing what each will study and what experimental methods and endpoints will be used. Commonly, a multiyear proposal will include three aims.

The remainder of the science portion of an application provides details of issues raised in the aims page. Typically, three features are expanded upon. The first is the significance of the problem under study — essentially your justification for why the work as you propose it should be done. Included in this discussion should be a concise tour of the relevant literature to highlight what shortcomings or contradictions in current understanding are going to be addressed by your work. Note that in developing this section you should

whenever possible have a sense of who the potential reviewers of the grant will be. Make a point to highlight their contribution to the field, and be careful not to exclude or unnecessarily criticize work they have done!

The next area to highlight is the innovation of your approach to the problem. This may include conceptual and methodological innovation. While some very un-innovative grants may succeed (e.g., a proposal that offers to definitively address some nagging question in the field), usually you want to provide something truly new in your work. It is in this way that both your own career and medicine broadly can advance.

Last, you need to describe in as much detail as possible your approach to the problem. Describing your methods requires a careful balance of providing enough detail that an expert in the field will know what you are going to do and avoiding too technical a description that non-experts will get lost. Included in your discussion of approach needs to be some provision of preliminary data you have related to the project. While some types of applications indicate that no preliminary data are required, you should endeavor whenever possible to provide some indication that what you propose can be accomplished. This could be a reference to a published manuscript by yourself or a collaborator or mentor. If that's not possible, then even the simplest data may still be helpful. For example, if you are proposing to study new approaches to unstable angina, a table of the number of cases your ED sees in the course of a year, their demographic features, and their outcome can be very useful to a reviewer trying to determine if you can do what you propose.

WRITING THE SHELL

The shell is the other major part of any grant application. It describes details of your budget, the resources available to you as an investigator, and other features of the institution(s) where the work will be carried out. For many junior investigators, the shell is an afterthought. This is a mistake, and occasionally one that prevents the application from being submitted before an application deadline. Challenges related to the shell include:

- It requires documentation of many features of your institution's research enterprise about which you may be unfamiliar.
- It will almost certainly need to be assembled by someone other than yourself and so therefore must be managed, not just written.
- It must include biographical summaries — usually called biosketches — of each member of your research team. This requires that your collaborators keep these documents, which typically include publications and other grant support, up to date. This challenge is compounded by the recent inclusion in NIH-format biosketches of a personal statement, which usually has to be rewritten for every application being submitted.
- Unlike the science portion of the application, it usually requires administrative approval prior to being submitted to the sponsor. It is common for a shell to require sign off by 4 or 5 different individuals in your institution, including people in your department, the medical school, and the central university. You *must* allow enough time for the proposal to be reviewed at each of these levels.

A NOTE ABOUT LETTERS OF SUPPORT

Particularly for junior investigators, letters of support are key parts of the shell. The goal of a letter of support is to document that a collaborator, mentor, or other important member of the research team is prepared to participate in the proposal. As they are outside of the page limit for most application types, letters of support are a useful opportunity to drive home key points in the proposal. The way to accomplish this is to participate in the writing of the letter. As a rule, you should take an active role in the penning of your collaborators' letters of support. You will more intimately know your proposal than they

will, and you can much more specifically highlight their role in the body of the letter. A common practice for letters of support is for the principal investigator to write first drafts, with the signatory making editorial changes as they see fit.

The most important mistakes to avoid when gathering letters of support are these:

- The letter is vague about the collaborators' role, suggesting the individual is not truly engaged in the work.
- The letter is tepid in its enthusiasm for the project or the applicant. Note that this can sometimes happen accidentally—descriptive terms in letters of support, such as "good," "excellent," and "outstanding," have subtly codified meanings just as they do in letters of recommendations written for students applying to postdoctoral training or residency programs. Junior collaborators may use inappropriate terms to describe the work.
- The letter makes a misstatement about the work that reveals that the collaborator has misunderstood their role or an important technical detail.

If you have questions about what constitutes a supportive letter, ask colleagues for examples.

BEING FRIENDLY TO REVIEWERS

As mentioned above, your grant needs to compete against others' proposals. This means doing everything possible to leave reviewers — frequently overworked and reading under a deadline — with the most favorable impression that you can. It is useful to remember that a typical NIH reviewer will usually not spend more than one day looking at your proposal, and that study sections at the NIH will typically evaluate 100 to 150 applications in 1½ business days. When your application comes up for discussion, it will likely have about 10 minutes to stand or fall before a committee of the nation's experts in the field.

How do you make your application reviewer friendly? The most important thing is to clearly propose good science. Great ideas can survive poor grantsmanship, but less-than-perfect proposals can unnecessarily fail due to poor writing. The most important way to make sure your proposal is clear is to have many colleagues edit the proposal before it goes out the door. This should include experts who can dissect small details in the work and one or two readers completely unfamiliar with the area who can comment on whether you will be understood by a broad audience.

A common misconception is that the writing style in a grant proposal is the same as that in an original manuscript submitted for peer review and publication. This is not the case. The primary objective of a written manuscript is to accurately, concisely, and in an objective manner convey new information. The primary objective of a grant proposal is to generate a sense of enthusiasm in a reviewer by emphasizing a new idea, a clever approach, and a high likelihood of success. The typically dry writing style of a scientific manuscript will likely not achieve a grant writer's primary objective. Similarly, long stretches of solid text without interruption by figure or table make applications difficult to read and tend to make even the best stretches of text seem a long slog for a likely rushed reviewer. Now that most applications are distributed electronically to reviewers, be sure to include color in your proposal. It significantly aids readability. A useful skill for you or someone in your team is proficiency in illustrating or desktop publishing software. Figures that are generated by software other than the usual word processors can be eye catching solely because of their novelty and are thus very useful to drive home key points. Note that the need to generate enthusiasm does not eliminate the need for highly accurate wording — an applicant's expertise in part is indicated by their ability to succinctly include great technical depth in their application.

Additionally, organization and attention to administrative detail are very important. Grants with typographical errors are a severe example — given that contemporary word processors include spell and grammar checking automatically, misspellings suggest sloppiness and poor planning. Well-organized, "spotless applications" indirectly suggest that you as an applicant are capable of overseeing the science in a competent and professional way.

REJECTION AND RESUBMISSION

Throughout your career, your grant applications will be more likely to fail than succeed. That is true of every investigator; senior investigators that accumulate significant funding over many years do so by writing grant applications frequently and learning from inevitable mistakes. For investigators seeking funding from the NIH, a 30% success is an admirable accomplishment. Therefore, how you respond to rejected grants will become an important part of your success as an investigator. A detailed, critical review of your work is priceless in determining your future research. You may not always agree with the review, and reviewers are not always correct. Nevertheless, an honest unblinking critique is essentially an expert in the field taking the time to specifically think about your work and is an enormous opportunity for course correction and insight.

In many instances, sponsors will be willing to reconsider rejected grants in subsequent review cycles. Rejections at the NIH are so common that there is a specific portion of the application devoted to describing how the proposal has been improved after having been previously turned down. An important part of planning any large grant is anticipating in its first submission that it will be rejected; a key to research program longevity is being able to keep your research mission moving forward while you wade through submission, review, resubmission, and re-review.

When a grant you have submitted is rejected but the opportunity to resubmit exists, begin by stepping away from the review for a couple of weeks to clear your emotions. Once you are no longer angry or frustrated, the work of resubmitting can begin. Reviewer comments typically center on significance, innovation, approach, and you as an investigator. All of these will need to be addressed in a resubmission. As a writer, I am most happy when I receive criticisms of approach — it is usually straightforward to change methodology to sway reviewers. Concerns about innovation often can be similarly addressed by adding new methodologies in the revised proposal. Reviewer concerns over significance are the most difficult to address. Reviewers that are unconvinced that your proposal's focus is important will be difficult to convince otherwise in most instances. A strongly worded negative comment regarding the impact of your project shakes the foundation of the work. In the event you receive reviews calling into question such fundamental features of your science, you should seek counsel of senior investigators you can trust to speak frankly about your work and how to proceed.

Should you decide to resubmit your application, and in most cases you should, important points to keep in mind during rewriting the proposal include:

- Making note of features about which reviewers made positive comments; highlight the acknowledged strengths of your proposal.
- Addressing every criticism in some way. In most cases, you should change your approach based on reviewer comments — they are usually right. You should provide a counter argument to a reviewer comment only very infrequently — perhaps one or two comments for an entire proposal. Suggesting to reviewers that they are uninformed accomplishes nothing.
- Having colleagues not involved with the work carefully check the language of your response for unnecessarily aggressive or defensive tone. Reviewers are not looking to start a fight, and you should not either, and it is surprising how inadvertently argumentative phrases can appear in your text.

- Remembering that reviewers know who you are and that interacting over rejected grants can set the tone for the evaluation of future submissions. Your response to tough review may be the most direct opportunity expert reviewers have to interact with you. Having a reputation for being someone responsive to criticism is valuable as you navigate your career. Being able to separate subjective and objective aspects of peer review will be noticed by the sponsor and is an important attribute looked for in future study section members.

GETTING PUBLISHED

Donald M. Yealy, MD, FACEP

INTRODUCTION

Sharing observations, insight, and knowledge about medicine is central to improving care of the many. Scientific journals serve a key role in this process — evaluating the work of authors, helping to hone the efforts, and creating a platform for others to read and judge the end product. While lay journals, trade publications, and other media formats all allow contact with users, this chapter will focus on the process of getting a submission accepted in a scientific journal and will not focus on the other options for sharing insights or messages.

Most scientific journals use pools of scientists that share a common interest and general background in a topic or field to evaluate submissions, called *peers*. Henry Oldenburg became the editor of the first peer-reviewed scientific journal in 1665; his use of these scientific peers to review, assess, and refine submissions was new and immediately assailed by some authors and experts. Despite those still ongoing protestations and evidence that scientific peer review is often variable, inconsistently used, flawed, and simply wrong when evaluating submissions of others, the process continues today largely in the same fashion as implemented by Oldenburg. The peer reviewers (also called *referees*) are presumed experts, though the defining characteristics can vary widely and may include self-designation for some journals.

At its core, the *scientific peer review process does not seek to judge worthiness or truth*. The fundamental goals are to evaluate the potential impact, the reliability of the approach and observations, and the efficiency of message delivery. Before seeking publication, recognizing human nature and goals of scientific peer review are key — it will allow you to better craft a submission and to receive any feedback, especially if the latter is not positive. In short, the process attempts to assess matters with inherent and varying amounts of subjectivity embedded within each offering and each referee. Thus, important scientific messages can easily be declined and unimportant pieces accepted. While imperfect, a better method does not yet exist.

A small but growing number of scientific journals eschew this approach, accepting most or all submissions and allowing the broader community of readers to comment and refine the message after publication. This "open peer review" approach remains a fraction of the

current scientific output and has an unclear utility over the aforementioned prepublication peer review process.

Journals can publish articles in a number of formats — print only, print and electronically available (the most common), or electronically available only (an area of growth). Readers access journals through many mechanisms — open content, subscription entry, or institutional access via a group subscribing. As readers change and learning evolves, most journals are exploring transformations in style and delivery, including open comment periods, podcasts, enhanced stimuli, and personalized contents. Even with these changes, the following insights on targeting destinations and how to optimize this process will likely remain true.

CHOOSING A DESTINATION JOURNAL

The first important decision before creating a manuscript and submission is to identify *your core message and its influence*. Given the natural admiration for our own work, this is often best accomplished after getting input from those who have been through or performed peer review or who have topic expertise but no direct link to your work. In short, ask around, especially in the early phases of your career (though experienced investigators still fall prey to this same trap of misjudging the message or value.)

Targeting the ideal audience will guide the target journal(s) and aid manuscript creation. For example, a novel approach to treating out-of-hospital cardiac arrest that improves outcomes has broad appeal and provides a transformative message for many physicians and health policy experts; submitting to a broad based journal is a potentially successful pathway. Conversely, a study or review that evaluates the role of a monitor or intervention that alters a process of care in cardiac arrest but unlinked to a change in outcome or understanding is valuable, but appeals to a narrower audience. The first example may succeed in a high profile journal such as *JAMA, New England Journal of Medicine*, or *Lancet*, while the latter likely will be best suited for an emergency medicine–, resuscitation-, or out-of-hospital care focused journal. Shooting for "the most prestigious" or widest circulation journal with all messages will result in frequent rejection, long delays, and potential disillusionment.

Journals have topics and formats that are favored, usually detected by reading previous issues and by reading the instruction for authors (this latter point is a recurring theme in the path to publication success). The desire of each journal for original research (clinical or bench), reviews, case reports or series, and other formats will help you match your efforts and message to the right destination. Choose your destination based on that knowledge and obtain that knowledge before article submission. If you "just submit" without investigation, it is a recipe for rejection and wasted time.

Broad-based, high-profile journals seek to deliver messages across large groups of physicians and scientists, prod discovery or fuel thought, and change care. Specialty journals seek to attract a narrower group of readers and influence in an important but often less resonant way for those outside the target audience. Both *broad and specialty journals are important to advancing knowledge and care*, and specialty journals often harbor the seeds of eventual breakthroughs in thought or care. Initial observations, case series or preliminary trials will succeed in a broad-based journal peer review process when novel and seminal (think of original HIV and hantavirus reports); outside of this, these kinds of efforts are best sent to a specialty journal that serves a more select or focused audience. As noted earlier, this selection process is imperfect — high-impact messages are accepted and published in journals with a narrower focus, and broad-based prestigious journals often accept work that seems derivative or flawed.

Aside from message and audience matches, the *choice of a destination is often altered by perceived journal prestige*. This sense of prestige can arise from informal views or from circulation volumes — journals quoted in lectures or lay releases and those with bigger circulation means more potential influence of your message. Another way to assess prestige is through evaluating how often the work published is used by others. Many see the *impact factor*, a calculation of selected publication in a source journal that are cited over a specific time interval, as the guide for choosing a destination. Higher impact factors connote a more influential and hence prestigious journal. This measurement is a crude method of identifying "the best" and prone to manipulations that skew the calculation. Rather than allowing impact factor to trump the destination choice, a more prudent path is to choose a journal first on the message/audience match before allowing this calculation to influence the decision to submit.

AUTHORSHIP ISSUES

The first and *most important practical issue with authorship is to decide as early as possible who is an author*, followed closely by which position of authorship. Ideally, the roles and assigned duties are laid out before the study begins; absent that, clarify authorship before writing the manuscript. Conversely, leaving authorship decisions and discussions to the end of the process — after manuscript completion or when submitting — creates a cavernous opportunity for dissent, ill will, and other strife. Simply put, while an early meeting defining roles seems uncomfortable, it is much less uncomfortable than the late-stage disagreements and resolution attempts.

Most journals *require each author to have contributed in a meaningful way*, and most use some check list, declaration or attestation to document that contribution. The actions of authors are categorized in many ways but are drawn from these general roles: idea creation; study design and funding; study implementation and data collection; analysis of observations; and substantive contribution to manuscript preparation. An *author need not do all*, but an author usually should do two or more (though a prodigious effort in one area may suffice in select settings.). Partners who simply aid in data collection alone, perform basic data analysis solely, or who copy edit the final manuscript should be paid, thanked, or acknowledged but not granted authorship. This formal acknowledgement often requires written permission from the named contributor. The International Council of Journal Medical Editors has an excellent summary of this topic available and serves as a template for many journals (*http://www.icmje.org/ethical_1author.html*). Another simpler way to assess authorship is to ask "Could this work and manuscript happen as well without this author and can s/he take responsibility for the data and conclusions?"

Authorship ordering requires planning. The *person doing the most study effort or crafting the manuscript occupies the first author position*, and others go in order while recognizing the subjectivity of this ordering. If ambiguous, the person who drafts the majority of the core manuscript is usually the first author. The *last or senior author position* is seen as prestigious if the author is senior or a thought leader; otherwise, it simply is the last author. The *corresponding author* will submit and address any journal concerns; that is usually the first or senior author but may be another where appropriate. Multicenter trials often have many investigators, but that alone does not equate to named authorship. Journals vary in how this is handled, from a long list of qualifying authors to variation on a "on behalf of the XYZ Investigators" approach, with or without a named author(s).

Journals do not seek to judge or adjudicate authorship disputes — these are returned to the local institution for that process. *Honorary authorship* for influential persons who do not meet these criteria *and ghost authorship* where someone creates work but eschews responsibility *are fraud* and can lead to scandal and sanctions.

CREATING A MANUSCRIPT

The *single biggest lapse* for new authors in creating and submitting a manuscript is a *failure to access and understand the journal's Instructions for Authors*. Here, the requirements for composition and submission are explained: formats, manuscript style and length, authorship, copyright, IRB, and other issues. These rules exist to allow the best review and the eventual best use of journal resources if accepted. As expected, many requirements may seem arcane or unattached to value by the author — I suggest following the requirements and not shunning those that seem ill-guided. Failing to adhere will create opportunity for true "reject without review" — that is, an administrative decline of your submission. Even if an administrative rejection does not occur, the editor and referees may develop a negative view about rigor or validity (often in error) because of the lack of proper manuscript construction. Why attach that "anvil" to the trek of the submission through peer review?

The next step is creating a manuscript that will succeed within the journal's peer process. Once you are armed with the general format and other requirements, the next hardest thing is to get started—overcoming "writer's block." For most authors, it is best to not write your first manuscript draft in the order it appears in print. *A practical tip is to write your initial manuscript draft in this order: Methods, Results, Discussion (and any subcategories like Limitations or Impact); Conclusion; Introduction; then Abstract*. While seemingly counterintuitive, this sequence ensures an easy start and will create natural brevity. Reassembling after this is an easier task than trying to remold ill-conceived sections. Starting with the methods and results allows a clear and less onerous flow of words — you likely created these before the trial and now simply hone or re-use. The goal in these sections is creating clarity and the ability of a reader to reproduce if desired. Detail can be offered in the body of the manuscript or as an attachment (often electronic now for great detail) — allow your journal and editor to jointly choose that with you.

By writing the discussion before creating an introduction, you will avoid having a long and dull introduction that fails to create interest. Also, *the discussion should explain how your data compare, contrast, refute or advance previous work — avoid restating results in your discussion* (a common error.) Also, the phrase "further research is needed" is trite and unnecessary because new research is always needed. Using this phrase will often create an image of inexperience in a referee (even if not true). You may note what the next logical research steps should be, but do not discuss aspects of your data that do not exist. This kind of speculation will often add length absent impact and create fodder for referee debate. In short, discuss how your data integrate with other data, and highlight your limits or opportunities for future improvement.

Writing the conclusion and introduction after the other sections will allow you to create a honed and enticing product. The introduction is meant to briefly say why the study was performed; *an introduction of three or four paragraphs maximum* is best, each paragraph being under six sentences. If you need more, it probably belongs in the discussion. The final introduction line(s) should clearly and tersely state what are your hypothesis(es), expectations, or focused goal(s). The conclusion should be a short three- to four-line response to that study objective and nothing more, particularly speculation or "future work" exhortations. *The last line(s) of the introduction and the conclusion should read like a question and answer only.*

Another pitfall in medical writing is the excessive use of passive voice, abbreviations, and long sentences. *You should seek clarity then brevity*. Passive voice — "subjects were screened and enrolled by us" instead of the preferred "we screened and enrolled subjects" — will often add both length and confusion. A rule of thumb is to keep the

passive voice to 10% or less of the total manuscript, reserving it for times when the object truly requires the prominent role. Similarly, avoid nonstandard abbreviations, which often confuse referees and readers. *When in doubt, spell it out*. Deploying a grammar and syntax checking program while spell checking will aid in eliminating syntax error and sentences fragments. Finally, any sentence over 30 words is a candidate for two shorter sentences or simple reduction. Following this rule of thumb will limit unneeded commas and convoluted thoughts. The key goal is saying things clearly and succinctly.

Tables and figures should follow the guidelines of each journal, and each should *be self explanatory and as simple as possible*. Readers should not need to peruse text to understand a table or figure. Additionally, data in each should not be repeated in the text; perhaps information from these can be summarized as needed but not restated. A good idea is to ask another to read each table or figure and judge "Does it look good and do you understand it?" Too much detail, overlapping lines or highlights, challenging fonts, and misuse of 3D or other features can detract from communication. As in the methods, some more detailed tables are often best shared as an electronic attachment rather than in the main body of the printed article.

Most journals have clear expectations about citations, including the number, vintage and style. The general rule is to cite key points or assertions and work that supports the current research underpinning or eases evaluation. *Avoid citing all potentially related references* — it is permissible to choose the most or best representative alone. Absent a structured review or meta-analysis, most scientific manuscripts need 40 or less citations, and most case reports or series need 20 or less.

A common series of concerns for authors and editors/referees is defining when does duplication and data splitting exist. Each can create barriers to acceptance, copyright concerns, and sanctions. Duplication refers to resubmission and republication of preexisting text data. *Resubmitting the same or largely similar data is always disallowed* and an opportunity for rejection or sanctioning. Consecutive submissions that add a few observations are often rife with this concern. Duplicating text is thornier, especially where the same author uses sections. Ideally, each entire manuscript is new, but in reality, the same author writing on the same topic will likely write similarly. The key is *avoiding large-scale and verbatim text duplication*, and never duplicating others work absent clear notation. With electronic search tools, duplication is easier to do and easier to detect.

Data splitting (also called creating a "least publishable unit") refers to breaking a linked dataset into smaller chunks to improve the volume of publications. *Data splitting risks rejection* since smaller data portions may fall beneath the threshold of acceptance and invite message loss. Journals discourage data splitting for publication volume alone and request notification of linked materials published or submitted elsewhere. Many trials result in multiple manuscripts given the complex topics and large data stores; the key question is, "Could one singular piece have been created?" *If you split data, be transparent* and clearly note the reason, ideally based in optimal message delivery and the underlying science.

One final piece of advice, hopefully attainable after reading above: *Do not exceed word limits*, and if you can, come in under the limit. Brevity is a co-factor in clarity, and a focused presentation will create a positive aura in the editor through the referees and readers. The original manuscript in 1953 by Watson and Crick describing the structure of DNA — the underpinning of modern molecular biology — was well under 1500 words, albeit in a different era. The approach outlined above will make compact writing more likely in your manuscript. Given the human component in peer review and in adult reading, a pithy approach is simply wise.

SUBMISSION PROCESS

After composing a manuscript that follows the chosen journal format, you will submit the article electronically. In addition to the manuscript, you will create a cover letter. That *cover letter should be one-page maximum, and should frame the importance and novelty* of your submission plus accomplish a few other tasks. This will aid the editing process, allowing you to focus the editor and referees and set a tone for the review process. The cover letter will note release of rights, any related submissions or publications for the dataset, detail funding streams, share permission needed for content, and state potential funding or conflict issues (financial or intellectual.) While not done in most cases, *you may ask for a specific editor or referee*, and you may also request one to be avoided. If requesting specific referees, keep these asks to one to three, briefly state the rationale, and avoid personal issues if possible. These requests are often honored but are not guaranteed. Some journals allow the requests to be made outside the cover letter and within the electronic submission process, which shortens the cover letter. Again, be brief, clear, and positive in the cover letter—transparency and nonhyperbolic prose will help avoid most traps.

For all clinical trials, it is important to also *document trial registration* (often ClinicalTrials.gov though other sites exist) *and local IRB approval*. Omitting or gaining either of these after data are collected will often exclude your trial from peer review, so these are actions requiring early planning and clear reporting at submission. Trial registration and IRB approval allow the editor, referees, and readers to know that the design was clear, consistent, and within regulatory bounds.

Once a manuscript is received, the administrative staff ensures that the submission rules were followed. If not, rejection or return is a common event; the most common is for failed IRB approval, nonacceptable formats, or incomplete submissions. Assuming you have complied with the rules, *the manuscript is assigned to an editor* with interest or expertise in the area. This editor also serves as a referee and decides "Does this fit our journal and do I need more input?" If the answer is no, rejection absent other input is chosen — this occurs to varying frequencies among journals. However, if the topic matches the journal's audience and the work has no major flaws, it will be sent to three or four other peers (sometimes more or less) for their opinions. This is most often done "blinded" — the referees do not know the authors' identity (the evidence of the benefit of blinding is scant). Those referees complete structure review sheets within a specified time interval, with portion of the comments shared to the editor only. *Referees suggest acceptance or rejection, but they do not decide on the disposition* — the decision editor does based on the collective input. It is rare that every referee has the same view, and some manuscripts disliked by a majority are ultimately accepted based on the decision editor's overall judgment of science and impact. *Peer review is not a democracy*, but it is a participatory process.

After the initial review, the editor may choose one of three general dispositions: *Decline to accept; accept (with or without some small revisions); or revise and resubmit.* For most journals, the rejection choice is the most common, followed by revision requests. Outright acceptance — particularly for unsolicited submissions — is a rare event that you should savor should it occur.

If your work is rejected, the best path is to wait a few days to "cool off" and then consider the feedback, and assess if submission elsewhere is next. You may choose to appeal the rejection, and journals each have approaches to this process. If you choose appeal, compose a letter that is *brief, factual and notes the errors in evaluation* that occurred — avoid personal attacks on the referees' intelligence or understanding and do not invoke bias absent clear evidence. Appeals are usually evaluated by another editor who then may agree with the decision, seek another pool of referees, or reverse the decision (the latter is rare). In the

vast majority of cases, it is best to not appeal and to find another journal for your message, incorporating the feedback from the review. Skipping that opportunity to alter your submission before sending it elsewhere may invite repeat rejection.

If your work is returned for revision, *attack this as quickly as possible* — delays invoke less crisp responses and may threaten the impact (especially if another submission similar to yours is accepted in this interval). Many journals set a time limit for revisions — adhere to this, and if that cannot occur, ask clearly and ahead of the deadline for an extension and note why this is needed. *Requests for revision are not a guarantee of acceptance*, but they are an indication that acceptance is possible. Respond to all requests either by changing what is asked or noting why a change cannot be accommodated — this is done in the text and in the follow-up response letter that will accompany the resubmission. Choosing to refute or debate most or all referee suggestions is a perilous path and may impair the ability of the editor to ultimately accept. On resubmission, the editor may simply choose a disposition, or re-engage peer reviewers, usually in a focused manner. The range of options after revision is the same as with initial submission.

When your work is submitted, the *prepublication process* will require copy editing by the publisher, draft manuscript checking by you and the publisher, and a final check for information accuracy and disclosures. Address each of these requests promptly to allow your work to stay in queue and become available as soon as possible. Most journals will release manuscripts electronically ahead of print distribution, allowing for early dissemination and feedback. If you find a postpublication error, notify the editorial office to allow prompt corrections to be made.

Peer review does not end with publication; the postpublication review is often how the ultimate impact is created. An editorial may accompany your work — you will not have input into that and may even disagree with the views. Only if factual errors occur should you seek to address the editorial comments in print. Letters to the editor may arrive for a set interval. If the editor sees potential in these letters, you will be given the final copy and a chance to offer a response. When replying, stay focused and respond with facts, grace, and candor. These in-print letter exchanges are usually kept current and "one round" to avoid lengthy debates. Finally, podcasts, blogs, and other social formats allow ongoing commentary and exchange, each with varying attributes and rules of engagement.

CONCLUSIONS

Getting research published requires discipline, focus, and an organized approach — and an understanding of the frailties of the common peer review process. Choose the best match between your message and the audience, allowing impact and prestige assessments to influence only after that match is optimized. Read the instructions for submission and follow them assiduously. Write the manuscripts methods and results first, and write the introduction and abstract last — this will help create the most crisp product. Finally, respond promptly when positive or neutral requests are made, and move on to another journal after rejection — if your assessment is correct, you will find a good destination for your work.

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THE TEN COMMANDMENTS OF EMERGENCY CARE RESEARCH

Adam J. Singer, MD, FACEP

INTRODUCTION

Development of a career in clinical research is both challenging and rewarding. Unfortunately, medical school education does not prepare physicians for a research career. While there was a time when a research career could be developed without any formal advanced training, gone are those days of improvisation and trial by fire. This chapter is an overview of what it takes to become a successful clinical researcher. We have chosen to present this information as the "Ten Commandments of Research" in order to emphasize their importance in career development. (See Table 10-1). It is our hope that these "commandments" will help pave the way for a successful research career. This chapter should be seen as a general overview. For further detail please refer to the specific chapters that follow.

FIRST COMMANDMENT: GET ADVANCED TRAINING

One of the keys to a long and successful career in research is receiving advanced training. Studies have shown that having advanced training in research enhances the likelihood of receiving federal funding. It also enhances your ability to get promoted and compete for highly sought after academic positions. Most experts suggest a minimal training period of 2 years. This advanced training may take one of several forms. Some medical schools offer combined programs for MD/PhD or MD/MPH. While few emergency practitioners will get a PhD after completion of medical school, many have received master's degrees in public health or clinical research. These programs can often be tailored to the individual needs of the budding clinician researcher and be taken offline or online in a full- or part-time capacity. Although a PhD is very useful in learning how to approach problems in a scientific way, it is not absolutely essential. Many physicians prefer "on the job" scientific training as a postdoctoral fellow and formal fellowships in research are available. Many of the best research fellowships are offered through the NIH (1). These include the career development K08 and K23 grants awarded to individual junior researchers and the T32 grants awarded

to institutions to help train researchers. A major addition to emergency medicine research training effort will be the newly established K12 awards for emergency medicine developed by the NIH. Another notable addition is the newly established pathway for SAEM certified research fellowships. In general, the most effective research training and career development programs tend to be localized to research-intensive academic institutions with sufficient resources, experienced investigators, and a range of ongoing research projects that can provide research fellows with hands-on training experiences. To be effective, research fellows should spend at least 75% of their time dedicated to research. Many institutions advertise research fellowships with "competitive compensation packages" and many rely on the clinical service of the "fellow" to support the fellowship, undermining the success of the program. These types of fellowships should be avoided if possible.

SECOND COMMANDMENT: FIND A MENTOR OR SET OF MENTORS

Finding the right mentor or set of mentors is critical to your academic success (2). The word mentor is derived from the Greek myth of Odysseus, who left his son in the care of his friend, Mentor, when he left for battle. According to Zerzan (3), a mentor is "someone of advanced rank or experience who guides, teaches, and develops a novice." The function of the mentor is to help you develop your career by assisting you to learn how to navigate the institution and the academic world, as well as helping you develop your research skills. A good mentor may also help you develop as a clinician, an educator, and a person; however, not all mentors are able to perform all of these roles. Having a good mentor increases self-esteem and job satisfaction and contributes to greater research productivity and success. Having a good mentor also increases the likelihood that you will pursue a lifelong career in academia and will be successfully promoted. Despite these advantages, many researchers lack a mentor, especially in emergency medicine, which lacks a large number of senior faculty.

A good mentor not only helps advance your academic career but also serves as a role model and a friend. Attributes to look for in an ideal mentor are patience, dedication, generosity, honesty, reliability, and altruism. While mentors may also benefit from your relationship, be sure that they focus on advancing your career and not their own. A good mentor does not tell you what to do but helps you to be able to make your own decisions. In addition to being your teacher, a mentor is your advocate and your advisor. A mentor should also act as your agent helping to protect you and overcome obstacles and barriers. A mentor is also your coach who helps motivate you and encourage you when you are discouraged. Finally, a mentor should serve as your confidante offering insights and emotional support as well.

Sometimes a single mentor will be able to fulfill all of your academic and personal needs. However, not all mentors are well suited for all of your needs and you should consider having several mentors with each mentor assisting you in a different area. Ideally, you will be able to find an appropriate mentor at your own institution and within emergency medicine. However, few institutions have a large cadre of mentors in emergency medicine. Thus you should consider finding a mentor from another specialty at your institution or from another institution. In addition, your mentoring needs are likely to change as your career unfolds.

While you may be lucky and be approached by a good mentor, most researchers will need to find a mentor on their own. This will require considerable time and effort and self-reflection. Make a list of your goals, strengths, and weakness to identify the areas most in need of mentoring. When approaching a potential mentor make a specific request. Make

sure that the mentor has the skills required as well as the time and motivation to work with you. If the mentorship relationship does not appear to be going well, discuss your concerns with your mentor openly and honestly and if necessary find another mentor.

THIRD COMMANDMENT: COLLABORATE

Modern research has become more complex than ever before, requiring a large number of skills and techniques as well as a vast body of knowledge. As a result, many of the most important advances in science are the result of interdisciplinary collaboration. With increasing specialization typical of today's world of medicine it is not possible for one investigator to know it all and be entirely self-sufficient. Thus, multi-institutional and multidisciplinary collaboration has become mandatory in research (4). Collaboration also allows for peer mentoring and cross-pollination leading to better scientific achievement. Prior studies indicate that prolific authors tend to collaborate more than less prolific authors, suggesting that collaboration will increase your scientific productivity. This may be especially beneficial in the middle stages of your academic career.

Due to a relative lack of research resources in emergency medicine at many institutions, a partial solution to the problem is to more actively seek collaborations with colleagues in other specialties and institutions, including some outside of medicine altogether. This may allow you access to greater scientific expertise and resources, such as funding and graduate students. The notion that collaboration facilitates excellent research has led to the development of centers of excellence and is one of the justifications for the recent establishment of the Clinical Translational Science Awards by the NIH.

Collaboration can be of varying forms from general advise to active participation in the research project. The value of such collaboration may also vary, at times being critical to the success of the project while at other times being of trivial nature. Interinstitutional collaboration is especially important when conducting large clinical trials or whenever your own institution does not have access to the types or number of required research subjects. While geographic proximity encourages and facilitates collaboration, distance should not be viewed as a barrier to collaboration, especially in today's high-tech era allowing better communication between collaborators.

Of note, before finalizing your collaboration be sure to consider issues such as responsibilities, funding and timelines as well as any authorship on future publications that may arise as a result of your collaboration.

FOURTH COMMANDMENT: MAKE A COMMITMENT AND BE PASSIONATE ABOUT YOUR WORK

A career in research can be very rewarding but demanding. To be successful requires a great amount of personal commitment and skeptical optimism. Problems and obstacles are common and should not be viewed as failures but rather as challenges and opportunities to grow and to learn. Commitment requires attention to academic scholarship and the need for ongoing self-education. You must *make* time for research and not expect someone to *give* you the time you need. Research can take considerable time and you will need considerable patience to see the project through. Try to get involved in projects that are meaningful to you personally. If you are passionate about your work you are more likely to succeed and avoid burn out. Thus, if you are not excited about your research find another area of research or seek a different career path. While you need to be realistic, never accept no as a final answer before exploring alternatives.

FIFTH COMMANDMENT: ASK IMPORTANT QUESTIONS

Excellence in research requires investment of considerable time, resources and effort. At times, these research efforts lead to a dead end, which can be extremely discouraging, especially for the novice researcher. Thus, before embarking on the often uncertain path of research, make sure that the research question being asked is really important and worth the effort regardless of the final results. Additionally, there is a much greater likelihood that your research will be publishable, whether the results are positive or negative, if the question is considered important. Many researchers have been greatly disappointed when their manuscript is rejected since it did not pass the "so what?" test. In addition, if the purpose of your research is to generate preliminary data for a larger grant application, the likelihood of funding is directly related to the significance of the research problem addressed.

Deciding whether your idea is important is not always easy and can be somewhat subjective. Share your idea with an experienced confidant to determine whether they share your enthusiasm for your idea before expending too much time and effort. Also, complete an extensive literature search prior to embarking on your research to make sure that you are not trying to reinvent the wheel.

SIXTH COMMANDMENT: BE HONEST AND HUMBLE

It is often tempting to ignore or omit negative results. However, your goal in research is to seek the truth. In order to do so you need to have some degree of emotional detachment that allows you to challenge your original hypotheses or even admit that you were wrong. The literature is replete with examples of dishonest researchers whose research could not be replicated and later found to be fraudulent, ruining their career forever.

In order to gain the respect of your colleagues and peers, you must also have humility. Let your accomplishments speak for themselves, allowing others to praise your success. Lack of humility may lead to anger and resentment, damaging your professional relationships and your ultimate success.

SEVENTH COMMANDMENT: FOCUS

Emergency medicine is a large field with both great depth and breadth. As a result, many physicians in our specialty have an interest in multiple areas of research. However, in order to become a true expert in a field, one must resist the temptation to be involved in multiple nonrelated projects. This will only dilute your efforts and limited resources, resulting in great breadth but little depth. One of the most important things that funding agencies and promotion and tenure committees look at is whether an individual researcher is truly focused and has a deep understanding and expertise in a specific area of research. The ability to focus early on in a career is not always easy. Sometimes, when you have difficulty deciding on your area of focus, simply by choosing a particular mentor will automatically steer you in a particular area or direction. As noted above, before committing, make sure that this is an area that you are truly passionate about and can anticipate deriving pleasure from over the long haul.

While focusing your research in a particular area is important, be aware that your area of focus may shift or change along the way because of your research findings, your departmental or institutional focus or loss of enthusiasm from a particular area. Ideally, your area of focus should overlap the goals and mission of your department and your

institution. If you feel strongly about an area of research that is not of major importance to your department or institution you should consider moving to another institution where you will receive adequate support and appreciation to be successful.

EIGHTH COMMANDMENT: PLAN YOUR RESEARCH EFFORTS AROUND IMPORTANT MEETINGS AND PUBLICATIONS

In order to maximize the visibility of your research and receive maximal academic recognition and credit for your work, plan your research around meetings. This means that whenever possible, present your research at a regional or national meeting first and then publish it in a peer-reviewed journal. In order to achieve this, a major effort should be made to complete data collection and analysis several weeks before a major meeting in order to write and submit an abstract for presentation. Setting such deadlines also will help you focus and become more efficient. If data collection is incomplete or the analysis is not definitive, it is better to postpone submitting any abstract to a later date and meeting. After the abstract is accepted, work on writing and completing a full manuscript prior to presenting the abstract. This will make sure that you once again review the literature and are best prepared to address any questions at the meeting. During the meeting, collect any useful comments or suggestions by observers and incorporate these in your final manuscript when you get back from the meeting. Try to complete and submit your manuscript as soon as possible after returning from the meeting.

NINTH COMMANDMENT: THE ENEMY OF GOOD IS PERFECTION

Some of the most important products of a researcher are grant submissions and manuscripts. Great effort should go into preparing the best possible grants and papers prior to submission. However, many researchers are obsessed with the need for perfection, and as a result, rarely get around to actually submitting their grants and papers. This can be extremely discouraging and disheartening. Get as much assistance as possible from your mentor and colleagues. However, at some point you must dive in and submit your work to be reviewed. At times, it is best to leave the final review and editing to the journal's reviewers. Even if your grant or paper is rejected, the comments that you receive from reviewers are often invaluable to you allowing you to improve your work before resubmitting.

TENTH COMMANDMENT: LEARN FROM YOUR MISTAKES

If you have ever listened to "professional" critiques of papers and grants, you will know that one can always find some flaw or mistake within a research project or manuscript. Even well experienced and seasoned researchers make mistakes, which is part of performing research. The important thing is to always be on the lookout for such flaws or mistakes and instead of being discouraged or trying to hide them, seize the opportunity to learn from them. Some of the most important scientific findings have come from such mistakes. For example, had Fleming not allowed his microbiological specimens to become contaminated with mold, he might never have discovered penicillin.

Mistakes can also occur in how you relate to your collaborators or peers. These may have devastating effects on your career development, especially if they are ignored and repeated.

TABLE 10-1.

Ten Commandments of Research (*in no particular order*)

1. Get advanced training.
2. Find a mentor.
3. Collaborate.
4. Make a commitment and be passionate about your work.
5. Ask important questions.
6. Be honest and humble.
7. Focus.
8. Plan your research around meetings and publications.
9. The enemy of good is perfection.
10. Learn from your mistakes.

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1. *http://grants.nih.gov/training/careerdevelopmentawards.htm*
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3. Zerzan JT, Hess R, Schur E, et al. Making the most of mentors: a guide for mentees. *Acad Med.* 2009;84:140-144.
4. Katz JS, Martin BR. What is research collaboration? *Res Pol.* 1997;26:1-18.

WHERE CAN I RECEIVE MORE HELP?

Edward C. Jauch, MD, MS

Keith Borg, MD PhD

This chapter differs in content and format from the preceding 10 chapters; it is a reference reso urce to help residents and junior faculty identify additional training in classical research fellowships as well as post training masters programs. This chapter also highlights opportunities for intramural and extramural funding for the junior investigator.

ADDITIONAL TRAINING

Research training for residents

For emergency medicine residents, several opportunities for focused research training exist. Many emergency medicine programs offer dedicated research electives, lasting 2 to 4 weeks on most cases. Additionally, the Emergency Medicine Basic Research Skills (EMBRS) Workshop, offered by ACEP and EMF, is an 11-day, two-session workshop "designed by a task force of experienced investigators to help the physician with an interest in emergency medicine research get started." The online application is found on the ACEP website.

Website

- **EMBRS Online Application**
  http://www.acep.org/content.aspx?ekfrm=41208

Clinical emergency medicine fellowships

Emergency medicine is a broad discipline and has a significant reach regarding its clinical endeavors. Formal fellowship training in these clinical endeavors is typically offered by departments of emergency medicine and often includes an informal research exposure. While most do not lead to advanced degrees, they do provide the fellow with the opportunity to advance their research education. The spectrum of clinical emergency medicine-based fellowships is broad and includes cardiovascular emergencies, critical care emergency medicine, disaster medicine education, pediatric emergency medicine, out-of-hospital emergency medicine, environmental health, and other topics (1). These training opportunities can be located on the SAEM fellowship website. Fellows who invest an additional year dedicated to formal research training in these clinical based fellowships often obtain a master's of science in clinical research, master's of public health, or other master's degrees.

Several nongovernmental organizations also offer postdoctoral training. An example is the Robert Wood Johnson Foundation (RWJF) Clinical Scholars program. RWJF offers these training programs with the purpose of "… developing of physicians who will lead the transformation of Americans' health and health care. These future leaders will conduct innovative research and work with communities, organizations, practitioners and policy-makers to address issues essential to the health and well-being of all Americans." To date over 41 emergency physicians have been awarded RWJF Clinical Scholar Fellowships.

Research fellowships

Dedicated research fellowships, however, are different than the clinical fellowships described above. These research fellowships are designed specifically to educate the emergency medicine fellow on research methodology. For over a decade there has been an effort by emergency medicine organizations to formalize the format and curriculum of research fellowships (2). The intent of research fellowship standardization is to assure that applicants will receive the appropriate training, have access to mentorship, and be working in an institution that can provide the necessary resources to ensure appropriate training. This research training fellowship typically requires 24 months and may be dependent on previous research training and/or prior advanced degrees.

Additional fellowship training may be obtained within the context of an NIH-mentored career development grant that provides finite salary and research support. For health-professionals "who need 3 to 5 years of support for additional supervised career development," the Mentored Patient-Oriented Research Career Development Award (K23) award provides support for training in patient-oriented research, while the Mentored Clinical Scientist Research Career Development Award (K08) award provides support for health-related research that may not involve patients. More recently a new emergency medicine–designated award has been created by the National Heart, Lung, and Blood Institute (NHLBI). The purpose of the new NHLBI Research Career Development Programs in Emergency Medicine Research (K12) is "to develop multidisciplinary clinical research training programs in emergency medicine (EM) that prepare clinician-scientists for academic leadership roles and independent research careers in emergency medicine." This K12 award is a landmark event in the field of emergency medicine and hopefully will represent just one of several dedicated emergency medicine K12 awards in the future.

Websites

- **National Institutes of Health — Extramural training**
  http://grants.nih.gov/training/extramural.htm
- **National Institutes of Health — Intramural training**
  https://www.training.nih.gov/
- **NHLBI Emergency Medicine Research K12 Award**
  http://grants.nih.gov/grants/guide/rfa-files/RFA-HL-11-011.html
- **Robert Woods Foundation Clinical Scholars Program**
  http://www.rwjf.org/applications/solicited/cfp.jsp?ID=21301
- **SAEM Fellowship Listing site**
  http://www.saem.org/fellowship-directory

POST-TRAINING RESEARCH INFORMATION

The need to locate additional research information remains beyond formal training for fellows or residents who have decided to pursue research. Post-training research information may be obtained by contacting the research director within the department of emergency medicine, the college of medicine, or the university. More recently, the creation and awarding of the NIH Clinical & Translational Science Awards (CTSAs) have led to very organized and detailed resources that are available within those institutions to the local researchers. CTSAs also provide funding for junior investigators in the form of K12 awards. These are structured in a similar fashion to other K awards, protect up to 80% of a junior investigator's time, and provide some funds for research with a strong mentoring component.

Fortunately, the materials are also available online and can be accessed by anyone. Several CTSA-based websites are listed next in no particular order. These websites provide valuable information regarding the development of research projects and the conduct of research and provide information for postpublication resources. Furthermore, professional societies such as ACEP and SAEM also provide information on research opportunities for their members and have research committees that address research issues relevant to emergency medicine. ACEP has a research section that is a voluntary assembly of emergency physicians whose purpose is to network and discuss research opportunities.

Websites

- **CTSA Home page**
  http://www.ncrr.nih.gov/clinical_research_resources/clinical_and_translational_science_awards/
- **Medical University of South Carolina — CTSA**
  https://sctr.musc.edu/index.php/programs/success-center
- **University of California San Francisco — CTSA**
  http://ctsi.ucsf.edu/
- **ACEP Emergency Medicine Research Section**
  http://www.acep.org/Content.aspx?id=25066

FUNDING OPPORTUNITIES

Institutional

The greatest challenge for most researchers is obtaining sufficient funding to support their research. Funding is required to provide protected time for the researcher, but also to obtain and utilize necessary resources to perform the research. Departments of emergency medicine in most medical institutions often provide pilot funds for residents and junior faculty for the purpose of generating pilot data that can be used to support more competitive grant applications. Additionally most institutions, either at the college of medicine or university level, also have competitive grants for the same purpose of obtaining funding to conduct pilot studies and generate pilot data for larger applications.

Federal

Federal funding is considered the holy grail of funding sources for most researchers. The traditional source, the NIH, remains the largest source for medical research in the United States and in the world. These grants continue to be very competitive. Emergency medicine, as a particular research field, has not been competitive; however, over the past several years there is a growing interest in facilitating the development of emergency medicine researchers to become competitive for NIH grants and several opportunities that are specific to emergency medicine have been created specifically for emergency medicine. The NIH Emergency Medicine Roundtable is the product of several workshops that have detailed opportunities with an emergency medicine focus and are priorities for the NIH.

Other government agencies also provide funding for research, although not to the extent of the NIH. The Centers for Disease Control and Prevention (CDC), Agency for Healthcare Research and Quality (AHRQ), Department of Defense (DOD), and other government organizations such as the National Aeronautics and Space Administration (NASA) and the National Highway Traffic Safety Administration (NHTSA) also provide research support, although funding tends to be more specific and focused relative to the mission of the agency.

Websites

- **Agency for Healthcare Research and Quality**
  http://www.ahrq.gov/fund/
- **CDC/National Institute for Occupational Safety and Health**
  http://www.cdc.gov/niosh/oep/funding.html
  http://www.grants.gov/
- **Environmental Protection Agency — Funding opportunities from the National Center for Environmental Research**
  http://www.epa.gov/ncer/rfa/
- **Grants.gov — Source to find and apply for federal grants (U.S. Departments, i.e. Department of Defense, agencies, CDC, institutes, EPA, NSF, NHTSA, etc., federal grants)**
  http://www.grants.gov/
- **National Institute for Health, Office for Extramural Fellowships**
  http://grants.nih.gov/grants/oer.htm
- **National Science Foundation**
  http://www.nsf.gov/funding

Nongovernment and nonprofit organizations

Various independent organizations also provide limited research support. Professional organizations such as ACEP, through the Emergency Medicine Foundation (EMF) and the SAEM Research Fund, provide research funding, although most of these grants target the more junior research faculty. They both provide funds for medical student grants and resident grants and have been used successfully to transition junior researchers into successful career researchers. Nongovernmental organizations, a heterogeneous group of organizations that operate independently from local and national governments, typically have very focused aims and provide research support related to their missions. It is often difficult to identify these resources so utilizing the university's office of research, etc., may help uncover less traditional funding opportunities.

Websites

- **American Diabetes Association**
  http://professional.diabetes.org/Diabetes_Research.aspx?typ=18&cid=64376
- **American Heart Association**
  http://my.americanheart.org/professional/Research/Research_UCM_316889_SubHomePage.jsp
- **Doris Duke Charitable Foundation**
  http://www.ddcf.org/Medical-Research/
- **Duke University NGO Research Guide**
  http://library.duke.edu/research/subject/guides/ngo_guide/
- **Emergency Medicine Foundation — Grant opportunities in collaboration with ACEP**
  http://www.emfoundation.org/
- **Robert Woods Johnson Foundation**
  http://www.rwjf.org/grants/
- **Society for Academic Emergency Medicine**
  http://www.saem.org/grants

Industry

Many career researches are involved in phase III and phase IV clinical trial research funded by industry partners. Traditional sources for industry-related funding include those from pharmaceutical companies, device manufacturers, diagnostic and imaging companies, as well as informatics. Nontraditional funding sources from industry include those in the arenas of transportation, military/less-than-lethal equipment manufacturers, and protective sports equipment. Lastly, trade organizations representing specific areas of industry are also sources of potential funding for research in line with their missions, such as organizations representing tobacco companies, distillers/brewers, etc.

Numerous nonprofit, for-profit, and governmental organizations maintain web sites for ongoing clinical trials. Additionally, typically for a subscription fee, several agencies will provide email updates of clinical trial opportunities. Researchers in academic centers should check with their office of research to see if their institution has a subscription.

Websites

- **Center Watch — Private source for clinical trials information**
  http://www.centerwatch.com/
- **Clinical Trials — Governmental registry of federally and privately supported clinical trials conducted in the United States**
  http://clinicaltrials.gov/
- **Controlled Trials — British site that allows users to search, register, and share information about global randomized controlled trials**
  http://www.controlled-trials.com/

ADDITIONAL RESOURCES

Additional resources may be found on the Internet as well as in the medical literature and traditional books. Following are several additional websites, references to articles, as well as books that may be useful to the emergency medicine researcher.

- **Food and Drug Administration — Running Clinical Trials**
  http://www.fda.gov/ScienceResearch/SpecialTopics/RunningClinicalTrials/default.htm
- **Stone, J (2010). Conducting Clinical Research, Second edition. Maryland: Mountainside MD Press.**
  http://conductingclinicalresearch.com/
- **Friedman, L.M. (2010) Fundamentals of Clinical Trials, Fourth edition. New York: Springer**

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2. Blanda M, Gerson LW, Dunn K. Emergency medicine resident research requirements and director characteristics. *Acad Emerg Med.* 1999;6(4):286-291.