



Careers in **surgical research:**

*Basic science, clinical research,
health policy, and surgical innovation*

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General surgery stands out as one of the few specialties in which many residents pursue protected research time during residency. This research typically extends the residency training from five years to six to eight years, and many trainees legitimately question the value of extra time spent in research investigation. Robertson and colleagues recently suggested that the number of years spent in research before and during residency is significantly correlated with better research funding and subsequent academic growth as an attending surgeon.¹ In a survey of recent graduates of surgical training, Thakur and colleagues found that trainees who perform research in a certain field are more likely to do fellowships in the same clinical area.² More importantly, research can be a wonderfully rewarding and fulfilling experience, both for the surgical trainee and for the attending surgeon-scientist.

Being in research requires: a baseline inquisitive mind, strong intellect, and ambitious spirit; favorable circumstances, especially the existence of an inspiring and available mentor; and a source of funding. In view of the fact that President Barack Obama's stimulus package carries approximately \$16 billion in new funds for research and research infrastructure, funding is expected to become more accessible in the years to come. In fact, a total of \$10 billion of this money has been allocated for the National Institutes of Health (NIH), \$3 billion for the National Science Foundation, and \$700 million for the Agency for Healthcare Research and Quality (AHRQ), with definite opportunities and serious commitment to research on the horizon.

Traditionally, the concept of research in surgery has been associated with the "bench" model, namely, basic science research. In the next few paragraphs, we will explore the research options and opportunities available for the surgeon-scientist. The model has expanded in the last two decades beyond bench research to include clinical and outcomes research, health policy research, and even surgical innovation.

Basic science research

Basic science research has long been an integral component of many academic surgical departments, and past contributions of surgeon-scientists to modern medicine clearly tell the success of their endeavors. The current incorporation of dedicated research time in many surgical residency programs testifies to the importance of research and its place at the core of modern surgical training. In addition to the traditional focus on disease processes and treatments, the surgical basic scientist is in a unique position to assume a pioneering role in translational research.

There are numerous options available to individuals who wish to pursue basic science research. Three key decisions should be made upon entering the research world. The first choice to be made is a specific area of research, which is usually influenced by previous clinical experiences and general intellectual curiosity. The next step is identifying an appropriate research mentor, which may, in reality, be the first step, as interactions through the clinical realm may have already led to the de-

velopment of a mentor-mentee relationship. The third step—one that is often overlooked by the first-time researcher—is to ensure the availability of adequate resources to conduct the research until completion.

For many residents, one or two years of research time may already be incorporated into their residency. When residents stay within their own department, funding for their salary is often provided. If they seek research outside of their residency program or have already completed residency, then funding sources should be sought and secured. Several institutions, such as the NIH and the National Cancer Institute, have both extramural and intramural research fellowships. Surgical associations—such as the American College of Surgeons, the Society of University Surgeons, and the Association for Academic Surgery—all have competitive research fellowship awards, which help provide funds. In attempting to find an appropriate research position, the track record of the laboratory is important to assess; reviewing the productivity of previous research fellows may aid in such an assessment. The choice of a project that is simultaneously challenging and feasible is a difficult task but is necessary for successful research. In addition, collaboration with the laboratory personnel—including nonclinical scientists, doctoral students, and technicians—is essential for success in basic science research. As a surgeon, likely with limited experience in basic science research, such collaborations will be essential to the productivity in the laboratory. Working with a recently formed research team may not be optimal, given the short time frame a surgical resident usually has. Furthermore, the guidance of a mentor is a key step toward success. A mentor not only helps keep mentees on track but also assists them in clearing roadblocks as research projects unfold.

The advantages of choosing basic science research are abundant. Discoveries made on the bench-top may lead to advances in surgical science and subsequently improve the treatment of patients. The intellectual challenge itself is particularly rewarding, and scientific success is especially satisfying. In addition, the practical and scientific knowledge acquired are very valuable for progression in an academic surgical career. On the other hand, basic research might be frustrating at

times. Even perfectly executed experiments may not be fruitful despite invested time and careful scrutiny. Finally, because of publishing bias toward positive results, many lines of investigation may need to be attempted before a successful one with positive results is discovered.

Clinical research

If you see trends in the clinical behavior of patients and develop clinical hypotheses while performing your daily clinical duties, then you probably should explore clinical research, keeping in mind that scientific curiosity and intellectual sharpness are only the starting point. It takes enormous effort and discipline to be a clinical investigator; as Albright once noted, it resembles riding two horses simultaneously, representing the clinical world and the research world.³ In this analogy, any significant imbalance toward one or the other can lead to failure, as it is the bridging role of the clinician scientists that allows them to perceive which hypothesis is clinically relevant and which investigation methodology is actually feasible.

Clinical research, as the NIH defines it, has three major subcategories that the surgeon scientist can explore: patient-oriented research (such as clinical trials and therapeutic interventions), epidemiologic studies, and outcomes/health services research.

In surgery, randomized clinical trials are time consuming, difficult to design, and expensive to perform. In addition, when contrasted with medical clinical trials, such trials raise important ethical concerns with regard to patient randomization and practical concerns with regard to “blinding” of patients and surgeons. Nonetheless, randomized trials are essential, and surgeons are gradually overcoming methodological and logistical difficulties with multiple surgical trials performed in the last few years. More importantly, most high-quality trials require many years to complete and are thus more suitable for the attending surgeon rather than the surgical resident with limited research time available.

Surgical outcomes research is a favorite area for the surgeon-scientist and the surgical resident during their research years. Outcomes data have proven powerful and their implications on driv-

ing substantial quality improvement and crucial policy decisions have been at the core of surgical care improvement efforts. The young investigator or resident has access to large nationwide clinical databases that provide a rich substrate for high-quality surgical outcomes research. The National Surgical Quality Improvement Program (NSQIP) and the ACS-NSQIP methodology (www.acsnsqip.org) have been consistently validated as reliable sources of risk-adjusted surgical outcomes, and their databases are the source of multiple outcomes and quality improvement initiatives all around the nation. The Surveillance, Epidemiology, and End Results registry (seer.cancer.gov) currently collects cancer incidence and survival data covering approximately 26 percent of the U.S. population. Alternatively, administrative databases are also readily available through venues such as the Healthcare Cost and Utilization Project (www.hcup-us.ahrq.gov). This database, started in 1988, includes the largest collection of longitudinal hospital care data in the U.S., with all-payor, encounter-level information.

These databases enable research on a wide range of clinical hypotheses and health policy issues, including cost and quality of surgical care, medical practice patterns, health care disparities, and outcomes of surgical care at the national, regional, state, and local levels. In addition, there is a new frontier of clinical research in surgery, focused on areas of patient safety, quality improvement, and the derivation and validation of surgical quality measures. The Surgical Outcomes Club (www.surgicaloutcomesclub.org) has recently emerged as the premier venue for networking and sharing of outcomes research conducted all across the nation.

As with basic science research, effective mentorship for outcomes and health services research may be difficult to find within some surgery departments. Choosing an open model of mentorship and embracing faculty members from other clinical departments or schools can lead to very effective mentoring relationships.⁴ Initial funding sources for residents are usually from the hospital or department of surgery. Private foundations such as Robert Wood Johnson (www.rwjf.org) and the Commonwealth Fund (www.commonwealthfund.org) are also available for health services research. AHRQ (www.ahrq.gov)

also provides K awards in health services research for new investigators. With more than \$700 million dollars allocated to AHRQ alone, and with President Obama's repeated references to the need for health reform and increased efficiency and quality of health care, it is clear that research opportunities in these areas are bound to increase.

Health policy research

Clinical research and health policy research are intimately intertwined. "Good data make good advocacy," says George F. Sheldon, MD, FACS, Director of the ACS Health Policy Research Institute (personal communication, February 23, 2009), and academic surgeons often use clinical and health services research to drive health policy. Addressing the perennial issues of cost, access, and quality, as well as newer concepts such as evidence-based case reimbursement, will require well-modeled research. Surgical outcomes data influence treatment protocols for heart disease, cancer, and trauma, the three diseases that account for the highest U.S. health expenditures.⁵ Whether working on reducing surgical site infections, establishing more streamlined patient care flow, or eliminating health care disparities, the opportunity for surgeons to enhance policy through an academic approach is present. Academic surgeons establish and lead multidisciplinary quality-improvement efforts that collect and review clinical data to establish quality benchmarks for hospital, state, and national regulatory committees. Academic surgeons serve as consultants and advisors and are sometimes appointed to government service.

Health care is a \$2.4 trillion industry, the largest in the country. As the U.S. health care expenditures continue to grow, sound health care policy becomes vital. The surgeon's role as a leader in such policy is well established. Former Surgeons General Richard H. Carmona, MD, FACS, and C. Everett Koop, MD, FACS, along with former Senate Majority Leader William H. Frist, MD, FACS, are examples of surgeons at the frontier of policymaking. They have clearly shown us that a surgeon's impact through policy can extend far beyond the operating room. The American College of Surgeons has seen the potential for this type of tremendous impact and has acted on it by establishing the ACS Health Policy Research

Table 1. Examples of funded clinical and health policy fellowships available to surgical residents

Fellowship	Contact information
American College of Surgeons Health Care Policy Fellowship	George Sheldon Gsheldon@med.unc.edu
Brigham and Women's Hospital Center for Surgery and Public Health Arthur Tracey Cabot Fellowship	Atul Gawande Elizabeth S. Morse es Morse@partners.org
Dartmouth-Hitchcock Medical Center for Evaluative Clinical Sciences The VA-CECS Outcomes Research Fellowship	Sam Finlayson surgery.outcomes@dartmouth.edu
UCLA/RAND Fellowship in Health Services Research	Nanette Ramzan nramzan@ucla.edu
Washington University Department of Surgery Patient Safety and Quality Fellowship	Bruce L. Hall hallb@wustl.edu

Table 2: Examples of surgical innovation fellowships available to surgeons and surgical residents

Fellowship	Contact information
Stanford University Biodesign Surgical Innovation Program	Roula El-Asmar roula@stanford.edu http://biodesign.stanford.edu
University of Missouri–Columbia Biodesign and Innovation Program	Stephanie Carani caranis@health.missouri.edu http://www.mubiodesign.com/
University of Minnesota Medical Devices Center Fellows Program	Marie Johnson mariej@umn.edu http://www.mdc.umn.edu/MHfellow.html
University of Michigan Medical Innovation Center Fellowship	Medical Innovation Center UM-MIC@med.umich.edu http://www.med.umich.edu/ummic/index.shtml

Institute because, as stated by Dr. Sheldon, “Surgeons provide a unique contribution in the health care system.” Surgeons are responsible for some of the most valued and essential care in the health care system. Surgery is given credit for 60 percent of patient cure from cancer, and trauma systems led by surgeons save thousands of lives each year. For these reasons, among others, it is perfectly appropriate that surgeons continue to be leaders in the health care policy arena.

Young surgeons have become increasingly in-

terested in molding the future of the nation’s health care system. Surgeons now gain expertise in public health, law, and economics. The challenge becomes a dual one of accessing the most effective skills and experiences and melding them with a career in surgery. One venue for gaining the requisite knowledge is the ACS Division of Advocacy and Health Policy’s annual Joint Surgical Advocacy Conference. This conference allows participants to fully explore major health care policy issues with advocates and legislative staff. (For coverage of this year’s conference, see page 43.) Furthermore, the community surgeon can also look to the local and state medical and surgical societies and join committees dedicated to access, reimbursement, and quality issues.

Most state legislatures have pending legislation posted on their Web sites, and following the progress of relevant bills is an excellent way of maintaining expertise in local issues. In addition, many medical and surgical organizations have state lobbyists, and dedicating some time shadowing them can improve legislative acumen. Ultimately, becoming involved in the legislative cycle through formal testimony and advisement can be very rewarding. Serving on state commissions that evaluate specific health care issues can also be accomplished.

The College offers a health care policy scholarship that provides an opportunity each year for awardees to attend a health care policy symposium at Brandeis University. In addition, the American Association of Colleges of Osteopathic Medicine offers a health care policy fellowship specifically for osteopathic surgeons (<http://www.aacom.org/events/Pages/HPFellowship.aspx>). A list of formal

health policy training experiences can also be found on the Kaiser Family Foundation Web page (<http://www.kaiseredu.org/fellowships/default.aspx>). Table 1 on page 28 delineates some of the funded clinical, health services, and health policy fellowships available for research residents. This list is not intended to be comprehensive.

With the increasing national dialogue regarding our health care system, and with public sentiment becoming more resolved toward significant change, it is clear that we are in one of the most exciting times for surgeons to be involved in health care policy.

Surgical innovation

The field of surgery has advanced, thanks to a few visionary surgeons who had the ability to identify unmet clinical needs and the will to do something about it. Surgical innovation is an alternative pathway that can complement or form the basis of a surgical career. Because of several factors—such as the current complexity in technology, surgical subspecialization, and busier clinical practices—innovation is being increasingly left to industry alone. Lack of surgeons' involvement in this process may lead to the development of suboptimal solutions to clinical problems or to a focus on problems that may not be the most critical to address. Surgeon involvement is therefore vital in the process of innovation.

Innovation is the process by which creative ideas are successfully implemented.⁵ As such, surgical innovation is not only about creating a new device or coming up with a new procedure. It requires the identification of an important problem, the generation of an adequate idea, and the development of a concept to the point where it can be brought back to the bedside and have an impact on patient care. Transforming an idea into a useful innovation requires time; perseverance; commitment; and, particularly for medical devices, money.

The first step in the process of surgical innovation is to identify unmet clinical needs. Surgeons, being at the forefront of clinical practice, are in the ideal position to identify those needs, characterize them, and conceptualize possible solutions. Therefore, surgical innovation lends itself as an ideal discipline to complement a surgeon's clinical practice. Once clinical problems are identified and well

characterized, the next step is to brainstorm possible solutions and create a multidisciplinary team that can materialize those solutions. The team's composition will vary depending on the scope of the problem but typically includes engineers, technicians, business people, and other clinicians.

The extent and duration of involvement of surgeon-inventors will vary depending on the time and resources they are willing to invest and the other commitments of their practice. Some surgeon-inventors will take the idea as far as human testing or even commercialization whereas others decide to participate in the early development of an idea before passing it on to a team willing to pursue it further. Regardless of the decision, surgeon involvement is vital in every step of the development of the product or technique.

Pursuing a career in surgical innovation can

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be exciting and personally and professionally rewarding. In clinical practice, a surgeon helps one patient at a time. A surgeon-innovator has the potential to have an impact on myriad patients and help advance the field of surgery. Furthermore, it is easy for surgeons to visualize and relate to patient care the problems and solutions that are within the scope of surgical innovation.

There are several barriers that a surgeon-innovator has to overcome, however. Creating a multidisciplinary team can be challenging, but one has to recognize that an effective and proactive team is perhaps the most important ingredient of the innovation equation. Funding plays an important role in the development of the project. Funding for the development of early ideas usually includes a combination of departmental funds, small government-sponsored grants (in the form of research, development, or small business grants), personal funds, angel or venture capital investments, or corporate sponsorship from major corporations. The type of funding will obviously depend on the scope and stage of the project and the intention of the innovators. Surgeons can get involved in surgical innovation by learning the process on the fly or by obtaining formal teaching in the process of innovation. Several educational programs in the form of fellowships have been developed around the U.S. and abroad to help train people in the process (see Table 2 on page 28).

Conclusion

Whether one chooses the basic science research track, the clinical research arena, the health policy and advocacy path, or surgical innovation research, the opportunities are ample for success, productivity, and effectiveness. On a more personal level, research in surgery can be as rewarding to the surgeon-scientist as operating itself. It is the exact combination of clinical work and research in surgery that undoubtedly puts the surgeon in the unique position of advancing the clinically relevant (rather than any) basic science, testing the appropriate (rather than any) clinical hypothesis, advocating the urgent (rather than the exclusively political) health policy themes, and innovating the clinically needed (rather than only industry-sponsored) surgical tool. 

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