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Bridging the Gap from T to K: Integrated Surgical Research Fellowship for the Next Generation of Surgical Scientists

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Delivery of health care will perpetually change, but the foundation of medicine will persist to emanate from understanding the biological mechanisms of disease. Fewer than 2% of all physicians conduct research as their primary profession, but this small group has made profound contributions to science that benefit the entire profession.¹ The “endangered species” of the physician scientist has been on the radar of the medical community since the late 1970s.^{1–4} For nearly 4 decades, the NIH and academic medical societies have sought mechanisms to preserve and rejuvenate this invaluable group of clinician scientists capable of bridging the gap between the bench and bedside.^{3,5}

Since the late 1990s, the NIH's K Awards have been the preferred strategy to support the development of clinician scientists. These awards have evolved with increased diversity and financial support.^{3,6} The K award is the NIH's mark of commitment to productive research efforts and provides the nidus for establishing career research grants.^{6,7} Nonsurgical specialties have capitalized on this training pathway, resulting in a 2.5-fold increased success rate in obtaining NIH funding compared with their surgical counterparts.⁸ The percentage of academic surgeons independently funded for research is on a steady decline.^{9,10} We propose that interventions to restructure surgical research fellowships will help bridge the gap of aspiring academicians to independently funded surgical scientists.

Barriers to Training Surgical Scientists

Surgery requires intense and prolonged time commitments to develop an understanding of the disease processes and technical skills to complete patient care. Cutting-edge techniques and an aging US population have resulted in patients with advanced disease and more

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comorbidities, with exponential growth and intricacy in procedures.¹¹ Parallel to this evolution in the complexity of clinical care leading to increased specialization, advancements in biomedical knowledge have led to similar pressure for select expertise. The explosion of medical knowledge from the golden era of US Nobel Prize laureates in the 1960s created endless opportunities for biomedical research, but added layers of complexity to biologic processes that require multifaceted research teams.^{5,12}

The societal demands of providing sustainable affordable health care have changed the working environment of surgeons by increasing the economic barriers (protected time and financial support) to accomplish congruous clinical and research success.¹³ New faculty hires want and need to become independently comfortable with their clinical and operative skills and also earn a salary, which puts additional pressure on protected research time.¹⁴ In fact, even successful junior surgical scientists are vulnerable to discontinuity of research. A survey of the Society of University Surgeons, in which 99% of respondents reported continuity of research when starting their careers, indicated that more than one third stopped their research efforts before the age of 40 years. Almost three quarters attributed this to increased clinical demands.¹³ At the same time, their senior counterparts are taking on more administrative duties that are time consuming and compete for research efforts.¹⁵ Given the dual requirements of scientific knowledge and administrative skills for running a modern research team, it is not surprising that academic surgeons struggle to establish and maintain independent funding. Training residents to balance clinical and research endeavors is a logical intervention to prepare for these hospital and administrative pressures.

Contemporary Training Model

Inherent flaws in training for 5 clinical years interrupted by 2 to 3 years of protected research time do not transition trainees toward research independence. Lack of continuity of research after completing research is a problem. The inability to stay current with the investigation topic will make past endeavors challenging and obsolete.¹⁵ Medical specialties have avoided this dilemma with shorter training requirements and integrated research time during fellowships. In addition, a large solitary block of research time does not accommodate the requirements of an academic surgeon having to juggle clinical and research endeavors.

Beyond the structural flaws of research fellowships, there is a lack of proof of successfully training surgical residents in fundamental research principals.⁴ Resident research education is not structured and formalized,¹⁴ and is at the mercy of the laboratories' core-contributing faculty. Unlike clinical surgery, there are no board-certification examinations for research skills. Internationally, it is almost expected that residents will obtain an advanced degree during release time from clinical obligations. Residents who successfully complete these degrees have higher productivity and academic accomplishments.¹⁶ The past president of the Society of University of Surgeons, Dr Yang, noted that surgical research training needs to be reformed to prepare residents for academic careers and not just a credential for obtaining a fellowship.¹⁷ Continuous protected research to maximize scientific immersion, but no education in grantsmanship or practical experience in juggling clinical and research duties, no longer reflects the reality of an academic surgeon scientist.

Proposed New Training Model

Not all surgical residents pursuing research fellowships are expected to be surgical scientists, and they can be successful with clinical- and educational-based research at academic centers. As Staveley-O'Carroll and colleagues expressed in 2005, there are at least 4 distinct categories of academic surgeons that enhance a department's productivity: busy clinician surgeons, clinical investigators, surgical educators, and surgical scientists.⁷ Individual characteristics and ambitions of the training or junior surgeon matched to early and deliberate recruitment of each type of aspiring surgical academician is essential for success.^{7,9} By creating alternative options for surgical research training catered to career goals, residents will be better suited for the academic environment. We propose a model for training a surgical scientist that emphasizes core grantsmanship training, integration with clinical duties, collaboration, and continuity of research.

Our surgical scientists track requires 2 residents to alternate between the basic science laboratory with PGY3 and PGY4 clinical rotations in 12-month blocks during a 4-year fellowship (Fig. 1). Both residents will work with the same principal investigator on the same projects in a tag-team approach to promote research continuity and collaborative skills. Collaboration between the 2 residents is essential for the success of this fellowship. Both residents risk loss of productivity by not working together, which replicates the realities of academic surgery.

During the 4-year integrated training fellowship, both residents complete their American Board of Surgery–required clinical rotations for PGY3 and PGY4; simultaneously completing research projects and publishable papers and obtaining a Master of Science in Clinical Science (MSCS) degree. Submission of a development grant is required within 1 year of completing the fellowship. It is not expected that this application for a development award will be successful on the first attempt, but the feedback will provide the resident with insight about what improvements are required. This allows the resident to plan for fellowship or career opportunities to improve their grant. A successful development award during the first attempt would be a welcomed challenge to integrate protected time into fellowship or early academic career.

This surgical scientist fellowship is an example of improving the research experience for residents pursuing a translational science career, and we would not expect universal adoption. Resident programs should re-evaluate their research programs and implement strategies to have continuity in research efforts beyond a blocked research time. Research fellowship after surgical residency arguably has the benefit of continuity in research efforts for development of an independent project.¹⁸ This option is applicable to residents interested in clinician and educator roles. However, research longevity and early recruitment of surgical scientists are vital for success and likely cannot start this late in training.^{6,7,9,19}

Research fellowships promote surgical careers in an academic hospital.^{20,21} Many of these are a result of residents matching into advanced surgical fellowships and not research independence. Integrated surgical training creates a unique environment for the maturation of an aspiring surgical scientist as continuous clinical and bench-side research during a 4-

year period allows for interest and project objectives to evolve based on experiences in both arenas.

Conclusions

The aging and declining number of surgical scientists is a reality.³ As these legends in surgery prepare to pass the torch to the next generation, a deficiency of surgical scientists irrefutably exists. Research guided by surgeons who lack a fundamental understanding of research skills will put the investigator at risk of “paralyzed academic investigator disease syndrome,” due to a lack of understanding of the techniques and creative approach to solving problems and an inability to form and establish high-functioning interdisciplinary teams.²²

The University of Colorado has begun its first year of integrated research fellows with the intention of producing surgical scientists. The training program has set milestones to produce a clinically active surgeon to become competitive for career development grants before beginning specialty training. We caution that surgeons trained purely as technicians will not optimally lead to new discoveries. Surgical scientists must continue to be trained and active in both surgical care and translational research to benefit society with hypothesis-driven research taken from the bedside, translated at the bench, and delivered back to the patient population they remedy. We propose this new model of training surgeon scientists during residency training. It should be a part of our armamentarium for training surgeon scientists along with other paradigms.

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References

1. Gottesman MM. The role of the NIH in nurturing clinician-scientists. *N Engl J Med*. 2013; 368:2249–2251. [PubMed: 23675642]
2. Schafer AI. The vanishing physician-scientist? *Transl Res*. 2010; 155:1–2. [PubMed: 20004354]
3. Ley TJ, Rosenberg LE. The physician-scientist career pipeline in 2005: build it, and they will come. *JAMA*. 2005; 294:1343–1351. [PubMed: 16174692]
4. Armstrong AY, Decherney A, Leppert P, et al. Keeping clinicians in clinical research: the Clinical Research/Reproductive Scientist Training Program. *Fertil Steril*. 2009; 91:664–666. [PubMed: 19144332]
5. Goldstein JL, Brown MS. History of science. A golden era of Nobel laureates. *Science*. 2012; 338:1033–1034. [PubMed: 23180848]
6. King A, Sharma-Crawford I, Shaaban AF, et al. The pediatric surgeon's road to research independence: utility of mentor-based National Institutes of Health grants. *J Surg Res*. 2013; 184:66–70. [PubMed: 23582227]
7. Staveley-O'Carroll K, Pan M, Meier A, et al. Developing the young academic surgeon. *J Surg Res*. 2004; 118:109–113. [PubMed: 15099999]
8. Rangel SJ, Moss RL. Recent trends in the funding and utilization of NIH career development awards by surgical faculty. *Surgery*. 2004; 136:232–239. [PubMed: 15300185]
9. Mann M, Tendulkar A, Birger N, et al. National Institutes of Health funding for surgical research. *Ann Surg*. 2008; 247:217–221. [PubMed: 18216525]

10. Ratcliffe MB, Howard C, Mann M, del Nido P. National Institutes of Health funding for cardiothoracic surgical research. *J Thorac Cardiovasc Surg.* 2008; 136:392–397. discussion 398–399. [PubMed: 18692647]
11. Tisherman SA, Kaplan L, Gracias VH, et al. Providing care for critically ill surgical patients: challenges and recommendations. *JAMA Surg.* 2013; 148:669–674. [PubMed: 23754675]
12. Flier JS. Creating a Nobel culture. *Science.* 2013; 339:140–141. [PubMed: 23307720]
13. Ko CY, Whang EE, Longmire WP Jr, McFadden DW. Improving the surgeon's participation in research: is it a problem of training or priority? *J Surg Res.* 2000; 91:5–8. [PubMed: 10816342]
14. Suliburk JW, Kao LS, Kozar RA, Mercer DW. Training future surgical scientists: realities and recommendations. *Ann Surg.* 2008; 247:741–749. [PubMed: 18438110]
15. Chokshi NK, Simeone DM, Chari RS, et al. A survey of academic surgeons: work, stress, and research. *Surgery.* 2009; 146:462–468. [PubMed: 19715802]
16. Nuttall MC, van der Meulen JH, Browne JP, et al. An analysis of the Research Fellowship Scheme of the Royal College of Surgeons of England. *J Am Coll Surg.* 2005; 200:186–190. [PubMed: 15664092]
17. Yang GP. 2013 Society of University Surgeons Presidential Address: reassessing the Halstedian residency. *Surgery.* 2013; 154:137–142. [PubMed: 23889943]
18. Graham LM. Surgical research—facing new realities. *Surgery.* 1995; 118:123–129. [PubMed: 7638724]
19. Menger MD, Schilling MK, Schafers HJ, et al. How to ensure the survival of the surgeon-scientist? The Homburg Program Langenbecks Arch Surg. 2012; 397:619–622. [PubMed: 22362055]
20. Bhattacharya SD, Williams JB, de la Fuente SG, et al. Does protected research time during general surgery training contribute to graduates' career choice? *Am Surg.* 2011; 77:907–910. [PubMed: 21944357]
21. Ellis MC, Diggs BS, Vetto JT, Herzig DO. Trends in the surgical treatment of ulcerative colitis over time: increased mortality and centralization of care. *World J Surg.* 2011; 35:671–676. [PubMed: 21165620]
22. Chinoy MR, Moskowitz J, Wilmore DW, Souba WW. Basic science faculty in surgical departments: advantages, disadvantages and opportunities. *J Surg Res.* 2005; 123:153–157. [PubMed: 15652964]

Figure 1.

Distribution of time during integrated research fellowship. Projected time distribution for the 4 years of an integrated clinical-research fellowship. Years 1 and 3 are dedicated to protected research time with the completion of graduate coursework in clinical sciences. Years 2 and 4 are clinical periods with a portion of research time and prearranged blocked time off for completion of didactic coursework to meet the individual trainee's needs. Research during years 2 and 4 are dependent on collaborating with a fellowship peer for alternating schedules and making time for research beyond the 80-hour work week. This represents one resident's schedule. The other collaborating resident would have an inverted schedule with protected research during years 2 and 4. Black bar, clinical; gray bar, research; white bar, didactic.