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Submitting a successful National Institutes of Health career development award for the vascular surgeon scientist

Samantha Minc, MD, MPH[a], **Jean Marie Ruddy, MD**[b], **Caitlin W. Hicks, MD, MS**[c], **Tammy T. Nguyen, MD, PhD**[d], **Andrea T. Obi, MD**[e], **Nicholas H. Osborne, MD, MS**[e], **Tze-Woei Tan, MD**[f], **Areck A. Ucuzian, MD, PhD**[g], **Samir K. Shah, MD, MPH**[h]

[a]Division of Vascular Surgery, West Virginia University, Morgantown

[b]Division of Vascular Surgery, Medical University of South Carolina, Charleston

[c]Division of Vascular Surgery, Johns Hopkins, Baltimore

[d]Division of Vascular Surgery, UMass Memorial Medical Center, Worcester

[e]Division of Vascular Surgery, University of Michigan, Ann Arbor

[f]Keck Medicine of University of Southern California, Los Angeles

[g]Division of Vascular Surgery, University of Maryland, Baltimore

[h]Division of Vascular Surgery, University of Florida, Gainesville

Abstract

Obtaining a career development award from the National Institutes of Health (K award) is often an important step in establishing a career as a vascular surgeon scientist. The application and review process is competitive, involves many steps, and may be confusing to the prospective applicant. Further, there are requirements involving mentors and the applicant's institution. This article, authored completely by vascular surgeons with active K awards, is intended for potential applicants and personnel at their institution and reviews relevant information including strategies for a successful application.

Correspondence: Samir K. Shah, MD, MPH, Division of Vascular Surgery, University of Florida, 1600 SW Archer Road, NG-45, Gainesville, FL 36210 (samir.shah@surgery.ufl.edu).

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Obtaining a National Institutes of Health (NIH) career development award or K award is commonly held as a first step in the establishment of a research career for vascular surgeons who have completed training. K awards come in two varieties for clinicians—K23 awards involve direct interaction with human subjects, whereas K08 awards do not—and both provide for up to five years of salary and research support. Unlike most other mechanisms (eg, R01), K awards are also intended to help the applicant learn a skillset while conducting research.

Successfully obtaining a K award implies approval of the larger scientific community outside of one's institution and specialty. Prior studies have demonstrated high rates of future research funding and attainment of leadership positions such as division chief and surgery chair among a subset of K recipients in vascular surgery.[1] Many applicants are discouraged, however, by the enormous amount of work required alongside the modest rate of success—for example 39.1% of K23/K08 applications were funded by the National Heart, Lung, and Blood Institute in 2021.[2] Indeed, there are only 10 vascular surgeons with active K awards at present. The challenges involved have inspired dogma verging on superstition regarding the creation of a successful application. In this paper the authors—all clinically active vascular surgeons with current K awards—share our experiences and advice regarding the creation of a competitive K award proposal. This work is not intended to repeat or supplant the official funding opportunity announcement from the NIH, but rather to highlight our own experiences in the context of some general background information. We acknowledge that there are notable alternative pathways to building successful research careers, and we hope that this information will be helpful to those pursuing these as well.

CANDIDATE SECTION

One of the unique features of the K award is the importance placed on the candidate section. The candidate section is composed of three parts: the Candidate's Background, Career Goals and Objectives, and Candidate's Plan for Career Development/Training Activities During Award Period (Table I). This section occupies approximately 5 of the 13 pages allotted to the application and should not be taken lightly. Reviewers are evaluating the future potential of a candidate and placing the proposal within the context of the applicant's overall career and life.

Candidate background.

The candidate's background section is an important opportunity for the applicant to tell their story. It allows the applicant to turn their accomplishments, goals, and proposal into a memorable, cohesive story that humanizes and makes them memorable. In this section applicants should strive to (1) convey who they are, why they care deeply about their area of research, and why they are the perfect candidate at the perfect time and place to receive

a K award and (2) connect the pieces of their personal journey in a logical progression from early training to their current research focus. Examples include the following.

- The applicant is focused on a novel area of research that their NIH Institute is looking to build on.
- The applicant comes from an under-represented group that their institute is looking to support. This can include emphasizing that the applicant is a surgeon-scientist.
- The applicant is applying near the end of the 10-year early stage investigator period and needs to explain mitigating circumstances. A simple sentence (eg, “Now that I have received a green card, I am delighted to have the opportunity to apply for this prestigious award”) can answer any questions a reviewer may have about timeline. Another example is for physicians who may not have engaged in research until after residency or fellowship. A brief explanation will help to moderate reviewer expectations for early career research productivity and allows the applicant to highlight their tenacity and dedication to a research career path.
- The applicant is applying from an institution that is not a highly funded academic center. The NIH is interested in supporting institutions in underserved areas of the country to improve the research capacity of these institutions. Highlighting this may help to set reviewer expectations about the local availability of mentors and resources and help to justify mentors from other institutions.
- The applicant has made significant contributions in research in a different area and has pivoted to a new focus owing to a change in mentors or because of what was available during their training period.

The ideal background section highlights the suitability of the candidate for the K award and gives a clear vision of the long-term research and career goals of the applicant. It is important here to highlight the applicants acquired skills, awards and major publications, predoctoral and postdoctoral training, and previous funding. However, it is also critical that the reviewers understand that the applicant is still in an early career phase and has specific areas that require additional training and mentorship to achieve their goals. The final transition paragraph of this section is an ideal area to foreshadow the critical gaps in training that the applicant will be using the award to address.

There is no agreed upon stylized format for the background; the story can be told from whatever is the most compelling or logical point of view. For example, the opening paragraph of one of our applications reads, “As a vascular surgeon, I have had both the pleasure and frustration of caring for patients suffering from PAD [peripheral artery disease].” The next several sentences detail the research focus of the candidate, paragraphs 2 and 3 detail the qualifications and achievement of the applicant, and paragraph 4 details how this new work represents a departure from prior research focus. In a second example, the opening paragraph starts, ”My interest in human disease and science dates back to my youth and was fostered by an intense immersion in basic and life sciences at one of Michigan’s first competitive Mathematics and Science high schools.” What follows is a narration in paragraphs 2 and 3 detailing skills and achievements acquired in a timeline-oriented fashion

based on mentor lineage. In paragraph 4, the plan for advancement of the scientific program is painted in broad strokes.

Building a research record.

The purpose of the K award is to provide the recipient with the additional training they need to become an independent researcher. This means having enough, but not too much, expertise in an area, and having the right amount of preliminary data to be able to carry out a project, which also serves as a training mechanism for the recipient. The outcome of the research must be anticipated to yield sufficient data and expertise for the recipient to go on to successfully compete for independent funding (eg, R01).

Because of the importance of the K award as a mechanism to provide training to a highly, but not too highly, accomplished candidate, it is critical that the applicant deliberately and thoughtfully considers its place in their overall career plan. Ideally, the applicant has spent time creating a 10-year career plan that builds from acquiring preliminary data to receiving independent funding. An example of such a plan would have the first 3 years of the plan focusing on obtaining seed funding (either through awards or departmental start-up funds) to build a set of preliminary data. Ideally, this will then lead to an institutional level K award/ training grant (often a 2-year training grant available through a Clinical and Translational Science Institute) that will further develop the data so that it is ready for a K award (and demonstrate institutional support for the applicant). The K award will then become the bridge from preliminary work to a mature concept and body of work that is ready to be scaled up to the level of an R01.

A lack of this level of preparation, however, does not automatically disqualify the applicant for a K award. What is most important is to articulate a genuine and succinct narrative explaining how the applicant's current work make senses in the context of a K application and of their larger research goals.

Career goals and development.

The career goals and development section follow the background and is generally ½ to 1 page. The goals should logically follow from the background. Within the first paragraph the overarching, general long-term career goal should be stated. For example, "to reduce mortality and morbidity related to deep venous thrombosis" or "to improve the quality of PAD care," followed by a clarifying statement on how these goals will be achieved, the specific short-term goals of the career development award that will help to set up the applicant's research program, and specific longer term goals. As a rule, these goals are most easily digested by a reviewer if limited to three to five per category, clearly labelled, and separated from the text by bullet points or numbering. The short-term goals should include acquisition of specific skills, including those related to laboratory techniques, statistical methodologies, and scientific communication, as well as any plans for knowledge acquisition in a specific area. The long-term goals should highlight the specific mechanisms by which the larger general long-term career goal will be accomplished, for example: "To inform clinical decisionmaking surrounding the treatment of PAD using comparative

effectiveness research." Any goals related to potential leadership and mentorship in the applicants chosen research area could be stated here as well.

Training activities.

The final component of the career development section includes the specific training that will be undertaken during the grant. The major goal of this section is to explicitly state how the applicant will accomplish the short-term goals and how this in turn will lead to independence. Training can take several forms: short courses sponsored by the NIH or other societies, longer term graduate level coursework, departmental conferences, and journal clubs. A high-quality application will have a very specific plan for when each of these training sessions will occur and will state the cadence of recurring meetings. The level of granularity should include the frequency of meeting with mentors, which should match what is stated in the mentor's letter. As an example of how detailed this information should be: "I currently have a research office within minutes walking distance of all four mentors. This proximity has allowed for both scheduled and ad hoc meetings." This detail is especially important when members of the mentorship team are external to the institution. Within this section, the mentorship team is outlined briefly, and the specific knowledge gap and role of each mentor is highlighted. One should not be concerned that this information is repeated in the mentor's letter; rather, agreement between the mentor's letter and the candidate's career development component are viewed as a strength and a sign that all parties are on the same page. Many applicants find it helpful to include in this section either a chart or diagram of the timing of the training and mechanism, to more clearly relate how the skills will build on each other, with the last few years including R01 writing and submission.

RESEARCH PLAN

Specific aims.

Although the K award application has many valuable components, the Specific Aims page is arguably one of the most important. It is the scientific equivalent of the elevator pitch and needs to bring the same enthusiasm. What is the knowledge gap? Why is your idea the best way to bridge that gap? How are you going to prove it? Answering these questions in a clear and concise fashion is a key skill that researchers must master.

The components of the Specific Aims page include a description of the clinical problem to be addressed, a succinct summary of relevant data, statement of the hypothesis, and brief description of the experimental aims by which you plan to prove the primary hypothesis. A summary figure is also frequently utilized to graphically represent how each aim individually contributes to supporting the hypothesis. Each aim must be an independent experimental concept (not conditional) such that failure of a single aim does not preclude completion of the remainder of the project or prevent evaluating the hypothesis. A K award application asking for 4 to 5 years of support commonly includes two or three aims with subaims as needed.

The Specific Aims page is an iterative document, and a draft should be completed early in the application process to serve as a communication tool among mentors, advisory team

members, collaborators, institutional administrators, and others. This practice allows the team to provide feedback on the science, but more importantly acts as a declaration of the research career the applicant wishes to build and provides insight into the materials that are needed.

Building a research plan.

Once the Specific Aims of the project has been completed, the writer may then engage in assembling the 6-page Research Plan comprised of Significance, Innovation, Rigor, and Approach. The significance section of the plan includes a description of the disease process to be studied, the volume of affected patients or severity of morbidity, and inadequacies of current treatment paradigms. Formatting can vary, but ultimately the significance needs to expand on the details established in the Specific Aims to further explain why your project is important. As vascular surgeon-scientists, we are powerful investigators. The applicant must harness that first-hand experience of poor patient care outcomes to enhance the literature and emphasize the knowledge gap that the proposal addresses. Establishing this knowledge gap can also create space to integrate more preliminary data and justify the individual experimental aims and the overarching hypothesis.

Transitioning to the Innovation and Rigor sections involve an explicit case for why the proposed work is novel and scientifically rigorous. The proposal should include bullet points for each novel resource, new technique, and statistical analysis integrated into the experimental plan. These will likely follow common themes and can then be revised into three to five clear, concise Innovation statements and an additional three to five declarations with attention to rigor.

In the Approach section the applicant should go through each aim and subaim to provide enough experimental detail to convince the reviewer that the applicant can complete the study. This section can also be used to integrate preliminary data that support the primary hypothesis. Remember that although the subaims may interact in a stepwise or dependent fashion, the individual Specific Aims need to stand alone such that failure of one aim would not lead to complete study failure. Each aim ought to have a plan for statistical analysis, including a power analysis.

Writing the Expected Results and Potential Difficulties/Alternative Approaches subsections is often the most challenging and most scrutinized aspect of the approach. One must seek a balance between humility and grandeur that allows a reviewer to accept and promote the clinical impact of this project. Describing specific Expected Results for each subaim can facilitate clarity and direct patient-level correlation. However, consider addressing the Potential Difficulties/Alternative Approaches for each full aim, because this part will often incorporate different experimental techniques. At the conclusion of the Approach, a summary sentence can help to remind the reviewer of the clinical relevance and potential influence of the project.

MENTORING TEAM

When selecting mentors for the Mentorship Team, it is important to understand what the unique role of each mentor will be to support and strengthen the success of the Candidate's Plan for Career Development. Do not add mentors without a clear role for each. We suggest building a team that is multidisciplinary and contains all expertise relevant to the proposal, including other medical specialties and non-medical methodological experts (eg, biostatistician). Because the NIH K awards series are focused on mentored training, it is important to demonstrate to the reviewers that your selected mentors are invested in your training and collectively provide a defined path toward becoming an independent investigator.

Who and what mentor(s) to select.

The Mentorship Team is typically made up of the Primary Mentor and two to four additional mentors. The Primary Mentor should be a senior scientist who has a strong track record of training successful mentees and securing external research funding. Ideally, the Primary Mentor should be an established investigator within the NIH institute to which the Candidate is applying. It is important to articulate that the Research Plan in the proposal aligns with the technical expertise that the Primary Mentor can provide and does not overlap or compete with the Primary Mentor's current funding. It may also be beneficial to highlight that the Primary Mentor has collaborated with other members of the Mentorship Team to emphasize Mentorship Team cohesion. Of note, some of the authors come from less established research institutions, and were successful in achieving a K award with a Primary Mentor without major NIH funding (although they did have a research mentor on the team with an R01 to fill that gap).

The Research Mentor(s) should be a selected group of investigators who are experts in a specific field or technique that is relevant to the Research Plan. For example, if the Research Plan involves transcriptomic profiling and the Candidate does not have formal training in the bioinformatics required to analyze transcriptomic data, then an appropriate Research Mentor would be a published expert in bioinformatics and transcriptomic analysis. Ideally there should be a Research Mentor to complement key methodologies that are critical for the successful execution of the Research Plan that is not an established expertise of the Candidate. Alternatively, methodology expertise can also be provided through a Core Facility if there is no specific Research Mentor who can fit this role, but it should be emphasize that the selected Research Mentor is familiar with the application of the techniques proposed in the Research Plan.

The Physician-Scientist Mentor(s) will serve as professional development mentor who can advise the Candidate on how to successfully balance between clinical and research work. A common criticism for physician or surgeon scientist applicants is the concern for protected research time. It is important to emphasize throughout the application that the Candidate's academic institute, Department Chair, and Medical Group unanimously support the Candidate's protected time. The Physician-Scientist Mentor(s) also provide an avenue to demonstrate that the Candidate will have a guide for how to manage and secure protected time within his or her academic institute. Furthermore, Physician-Scientist

Mentor(s) offer an opportunity to provide professional development and translational or clinical trial expertise to guide the Candidate's future R01 application.

Rationale for mentorship team selection.

Once the Mentorship Team is selected, the Candidate will need to provide a rationale for each mentor and how each mentor will provide expertise to accomplish (1) publishable results from the Research Plan, (2) technical training to become an independent investigator, and (3) professional pathway to become a field expert. This section within the Candidate's Plan for Career Development can be done in short paragraphs describing each mentor's background, training record, established relationship with Candidate, and specific role on the Mentorship Team. The collective Mentorship Team can be summarized in a table for an easy visual for the reviewers (Table II).

INSTITUTIONAL COMMITMENT LETTER AND EFFORT CONSIDERATIONS

Generally, K award programs require the awardee to allocate at least 9 person-months (or 75% of their full-time effort) directly to the proposed research project and career development activities. The remaining 25% can be used for other purposes such as teaching, clinical work, administrative duties, or additional research. In the final 2 years of the K award, recipients can request to decrease the effort dedicated to the K award project to a minimum of 50% from the initial 75%. In some NIH institutes, such as the National Heart, Lung, and Blood Institute (K08/K23 award) and the National Cancer Institute (K08 award), surgeon-scientists who have active surgical duties can request a reduced effort, between 50% and 75% full-time professional effort, but not less than 50%. Candidates must justify their reduced effort, which is usually framed in terms of maintenance of surgical competency. Effort allocation should be discussed before submission both with department or division leadership as well as with the program officer.

The K award offers some salary support, including a maximum of $100,000 per year. However, in most cases, this amount is not sufficient to meet the preexisting salary level of a surgeon. Therefore, it is important to have an early and open discussion with the department or division leadership to discuss the application and any potential income loss that may arise from the K award.[1] This factor is particularly important for departments or divisions that have not previously supported a K awardee. There should be a plan to supplement the salary so that the income is not significantly impacted by the award. Another important topic for discussion is additional research support.[2] The maximum amount of funds provided by the NIH for K08 and K23 awards for the project itself ranges from $25,000 to $50,000, which is not enough to fully cover the costs of most research projects. Therefore, it is important to have a realistic research plan that includes planning to apply for additional funds. It is equally important, however, to demonstrate institutional support in the face of these funding limitations.

Given the extensive institutional support required for a K application, the institutional commitment letter as an explicit guarantee of this support is a critical aspect of the application.[1] The letter should be signed by a senior institutional official (commonly the department chair) and clearly state the institution's commitment to allocate 75% (or 50%

as appropriate) of the applicant's time to the proposed research and career development activities. The letter should also provide specifics of current or pledged support that the candidate is receiving, including salary support, start-up funds, and research assistants or coordinators. It should also provide assurance that the institution intends for the candidate to be an integral part of its research program, providing opportunities for continued growth and development beyond the K award funding period. This statement serves to highlight the institution's strong commitment to supporting candidates achieving their goals.

GENERAL REMARKS

Program officer.

The NIH program officer is the default point of contact for applicants. Prospective K applicants should send a draft of their Specific Aims page and request an appointment to discuss their application with the specific institute and K program officer early in the process. This process will ensure alignment with the interests of the institute. Program officers may also be able to help answer logistical questions. Most importantly, although program officers vary in experience, some will be able to provide valuable insights that may increase the chances of obtaining funding.

Grant logistics.

A failure to appreciate the basic rules and logistics of submitting a proposal will nullify even the most scientifically meritorious proposal coming from the most qualified applicant. The NIH websites contains detailed and complete instructions on application eligibility, requirements, and deadlines in its funding opportunity announcements (eg, https://grants.nih.gov/grants/guide/pa-files/PA-20-205.html). Applicants should read the funding opportunity announcements for the target K award carefully and completely. There are many components, and all are required to be eligible for scientific review. Mentors are likely to be many years removed from the process, which may have changed in the interim, and should not be used as the sole or final authority on logistical and regulatory issues. Questions should be directed to the program officer, whose name and contact information will also be available online. The grants office at your institution is a secondary resource.

Timelines.

There are three funding cycles every year. In general, scientific review and the earliest start date occur about 4 and 6 months after the submission deadline, respectively. Although there are no firm rules, preparation of a complete proposal will take 6 to 12 months. Applications are usually funded on the resubmission, so it is typical for the entire process to take 18 to 24 months. Although the applicant may complete their portions very efficiently, applications require substantial and iterative review and input from mentors, who have other obligations and cannot be rushed. As such, a disciplined forward-looking approach is essential and should be built on the assumption that every task will take longer than estimated.

Scoring.

K grants are scored on five criteria: candidate, career development plan/career goals, research plan, mentors/co-mentors, and environment. Three assigned reviewers provide a

score of 1 (best) to 9 (worst) for each category in addition to an impact score, which is an overall assessment and not a numerical average of the individual categories. Members of the study section not assigned to your application vote only on the impact score. The final impact score is the numerical average of all study section member impact scores multiplied by 10.

Summary statements and dealing with failure.

Approximately 4 to 6 weeks after the study section meets a summary statement with an impact score will be available on the application portal, eRA Commons. There are no percentiles for K applications. The summary statement will include a summary of the study section discussion as well as detailed critiques from each of the three assigned reviewers. The typical threshold score used for funding (payline) is usually available on the NIH website—for example, the payline for K awards for National Heart, Lung, and Blood Institute in 2022 was 28.[3] However, it should be noted that certain institutes, such as the National Institute of Diabetes and Digestive and Kidney Diseases, do not provide a payline for K awards. An advisory council will meet to make a final recommendation regarding funding, but the likely outcome can usually be predicted based on the summary statement. Submissions for K awards with scores at or better than the payline generally result in funding. Those with scores more than several points worse than the payline typically will not be funded. Applications with no impact score are said to have been triaged (ie, not discussed at the study section) and will not be funded. Therefore, even being scored should be considered a positive event for a first round application. Applications that are not funded but scored should be resubmitted with the aim of providing a complete response to each of the critiques in the summary statement. Because applications can only be resubmitted once, it is important to weigh the cost in time of waiting to resubmit vs any potential advantages in delaying. The precise strategy requires input from the mentoring team and program officer and relies heavily on the content of the critiques. For example, an applicant deemed to have an inadequate number of publications will have to wait much longer to resubmit compared with an applicant who is told they needs to make their mentoring team smaller. Triaged applications may also be resubmitted, but process this is more difficult by the lack of a summary statement. The applicant should try to glean as much as information from the program officer as possible to understand the underlying issue and work with the mentoring team to see if it is best to attempt to remedy these or start with a new application altogether. We cannot emphasize the importance of perseverance and anticipating failure—work with the assumption that you will not be funded on the first attempt and do not give up.

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Table I.

Components of the Candidate Section of a career development award

	Candidate background	Career goals and development	Training activities	Mentorship team
Questions to answer	What is the applicant's scientific background and training to date? What are the major previous achievements of the applicant? What disease process/clinical problem is the applicant studying?	What is the ultimate long-term goal of the candidate? What are the short-term goals of the career development grant? What are the long-term goals of the applicant that will help him/her achieve the ultimate long-term goal?	How will each training activity address your short-term goals? How will the training activities lead to independence? What is the timeline for publication and submission of R01?	Who will form the mentorship team? How will the mentors help to achieve the training goals?
Information to include	Previous training experience Major publications and awards Previous or current funding	Laboratory techniques Research methodologies Knowledge gaps Communication skills Leadership and mentorship goals	Coursework and training Departmental conferences Scientific meetings Manuscript writing Grant writing	Credentials and previous mentoring history of the mentors Frequency of meetings including location and availability of mentor

Table II.

Example of mentorship role table

Mentorship team			
Name	**Location**	**Method, frequency of interactions**	**Aim, area of expertise**
Translational/clinical research mentors			
Primary mentor			
Mentor #2			
Physician-scientist mentors			
Mentor #3			
Mentor #4			