Writing Effective Proposals – Creating conversations with reviewers, including patterns they expect to see…

Rick McGee, PhD and Bill Lowe, MD
Navigating the Research Enterprise – February 6, 2017
Overview

**TODAY**

A walk through a series of core principles in writing research proposals – NIH style but similar principles apply to all

Goal is to demystify the process – this is all learnable stuff!!!

Writing, thinking and refining research is synchronous – writing proposals is an essential tool for improving your science
What do you have to achieve in a proposal?

Demonstrate the research you are proposing is important, feasible, a logical next step, and hopefully innovative/novel

Show that you really understand the field, both the broad topic and the precise niche you are in – including best techniques

Show that you are actually working in the field

Demonstrate your prior research accomplishments are excellent and appropriate for your career stage

Write in a way that is crystal clear with every word serving a purpose – and for multiple types of reviewers

Convince the reviewers that you are a legitimate member of the NIH-funded research community
It all starts by understanding review processes and knowing your reviewers

In science we write for reviewers. To be a successful writer you have to start from an understanding of:

- What reviewers are used to seeing
- What they want to see
- The criteria they are using to judge what they read
- Their likely approaches to their task
- Knowing and writing to these shows you are legitimate

Your task is to turn the reviewer into your advocate:

- Make the work of the reviewer as simple as possible
- Convince them your work is VERY important
- Convince them you know what your are doing and you can conduct the research you propose
Writing for different types of reviewers

The expert, someone who knows as much, or more, about the topic as you do

The sophisticated non-expert

The skilled scientist who knows almost nothing about your specific topic

The technical expert – e.g. biostatistician or epidemiologist

A non-scientist who may still have a lot of input into review decisions and outcomes

KNOW YOUR REVIEWERS!!! You are writing for THEM.
NIH Information and Videos on Grant Review

Videos worth spending 20 minutes viewing!!


Guidelines for Reviewers

“Recent” changes in NIH grants and review

The review criteria and scoring system changed 6 years ago

- In theory, designed to put more weight on Impact and Significance – importance of the work

Review criteria changed in subtle ways

Page lengths for most proposals substantially changed as of January 25, 2010

Smaller changes in emphasis and review of fellowships and K awards
Know the review criteria

Overall Impact – the score that matters

Core Review Criteria for Research Proposals

• Significance – may be global or within a field
• Investigator(s)
• Innovation
• Approach
• Environment
Significance

**Significance.** Does the project address an important problem or a critical barrier to progress in the field? If the aims of the project are achieved, how will scientific knowledge, technical capability, and/or clinical practice be improved? How will successful completion of the aims change the concepts, methods, technologies, treatments, services, or preventative interventions that drive this field?
Investigator(s). Are the PD/PIs, collaborators, and other researchers well suited to the project? If Early Stage Investigators or New Investigators, do they have appropriate experience and training? If established, have they demonstrated an ongoing record of accomplishments that have advanced their field(s)? If the project is collaborative or multi-PD/PI, do the investigators have complementary and integrated expertise; are their leadership approach, governance and organizational structure appropriate for the project?
Innovation. Does the application challenge and seek to shift current research or clinical practice paradigms by utilizing novel theoretical concepts, approaches or methodologies, instrumentation, or interventions? Are the concepts, approaches or methodologies, instrumentation, or interventions novel to one field of research or novel in a broad sense? Is a refinement, improvement, or new application of theoretical concepts, approaches or methodologies, instrumentation, or interventions proposed?
Approach

Approach. Are the overall strategy, methodology, and analyses well-reasoned and appropriate to accomplish the specific aims of the project? Are potential problems, alternative strategies, and benchmarks for success presented? If the project is in the early stages of development, will the strategy establish feasibility and will particularly risky aspects be managed? If the project involves clinical research, are the plans for 1) protection of human subjects from research risks, and 2) inclusion of minorities and members of both sexes/genders, as well as the inclusion of children, justified in terms of the scientific goals and research strategy proposed?
Environment

*Environment.* Will the scientific environment in which the work will be done contribute to the probability of success? Are the institutional support, equipment and other physical resources available to the investigators adequate for the project proposed? Will the project benefit from unique features of the scientific environment, subject populations, or collaborative arrangements?
New Review Template

Bulleted list of reviewer comments on strengths and weakness for each criterion

Much quicker to prepare and read – not necessarily easier to decode

Strong goal of reviewers to ‘fill in the blanks’ so it is to your advantage to help them do so – be explicit rather than hoping they will find things
Page Limits and Grant Types

R01 and similar others – 1 page Specific Aims plus 12 page Research Plan – used to be 25

R02, R13, R21 – 1 page Specific Aims plus 6 page Research Plan – used to be 12

K01, K08, K23 – 12 pages for Candidate Information and Research Strategy – used to be 25

K99/R00 – a bit of a different beast
Page Change Implications

Specific Aims page continues to be critical first impressions
Overall writing style must be very compact and crisp – no wasted words!
Less focus on Background – very targeted historical perspective with the purpose of establishing Significance and Innovation
Preliminary data must be streamlined if you have a lot – still critical
Carefully choose details given in the Approach section – potentially broader brush than in the past
Must make impact/novelty/innovation very obvious but it must be legitimate! – Critical to the field if no direct health impact
The overall writing style should ‘tell a story’

Think of it as guiding or controlling the thinking of the reviewer – cognitive control

This includes consciously considering what a reviewer might be thinking and writing to it

• Particularly critical if there is controversy in the field and/or what you are proposing might challenge current thinking!

Don’t forget to write toward different levels of reviewers

MUST employ rigorous technical writing standards

• Paragraphs really do need meaningful topic sentences
• Each sentence must be logically connected
• The last sentence of a paragraph must sum it up and/or make clear to the reader where they are headed in the NEXT paragraph – see videos on sentences and paragraphs

http://www.northwestern.edu/climb/
Grant Sections – what to accomplish in each

Specific Aims – 1 page
- One page synopsis of the proposed research
- Starts from setting the context – a funnel with steep sides
- What is the problem or need?
- Why is it important/significant?
- What is known – from other’s work to your own?
- What new information do you hope to uncover?
- What is specific question(s) are you asking and/or the hypothesis you are testing?

Bulleted list of Specific aims – what you plan to do – usually with a sentence or two of detail

Impact Statement
Crystal clear to the reader why what you are proposing is important and what you will do

Make or break for reviewer enthusiasm!
Research Strategy – 3 Sections

Significance = importance

• Previously “Background and Significance”
• Much less emphasis on Background but builds the context behind the question and proposed research
• Establishes the logic path to what you propose to do – easy to forget to make logic clear – you know it and fill in blanks
• Convinces the reviewer you know the field and what is important to pursue vs. less important
• Expands what is provided briefly in Aims page
• Preliminary Data might come in here but probably not – or mentioned here to be expanded upon in Approach
• Likely 1-2 pages of 12 page R01
• Work MUST be significant even if not highly innovative!
Research Strategy – Innovation

Innovation = novelty

- New section – new emphasis

Either not included or lower contribution to fellowship (F) and Career Development (K) awards

The logic may be innovative or the methodological approach – may bring new observation in one field to another

New technologies open up possibilities for innovation

In theory, innovation should give permission for higher risk science but still not always ok with reviewers

Innovative work still must be logical and being reasonably feasible!

Sometimes hard to separate from Significance
Research Strategy – Approach

This is the section where you say exactly what you plan to do to achieve each Aim and test each hypothesis – organized by each Specific Aim.

You can have a section on methods that apply to the entire project but more common recently in each Aim – but not repeated.

Aims should relate to each other but not be dependent on a specific outcome for a previous aim.

Scores on Approach most closely align with Impact score for R proposals!!
Preliminary Results

Where to include them is not strictly specified

- Best to ask yourself: “When does the reviewer most need to know about them?”
- Where will they have the most impact?
- Often best to mention in more than one place with different levels of detail - often first mentioned in Specific Aims
- Often in Approach with the Aim they apply to
- If preliminary data sets up the entire approach it can be provided as a beginning section or can be in Significance
- Make a clear distinction between reference to your own previously published and unpublished data
- Must keep them compact – no room for large number of tables and figures
Rigor and Transparency

- **Scientific Premise:** The key data introduced by the applicant to justify the project.

  “The applicant should supply a sufficient evaluation of the strengths and weaknesses of the data or other justification used to support the application, and should describe how the proposed research will address any weaknesses or gaps.”

- Addressed in review of **Significance** criterion for R grants and **Research Plan** in K
Rigor and Transparency

- **Scientific Rigor:** The strict application of the scientific method to ensure robust and unbiased experimental design, methodology, analysis, interpretation and reporting of results.

  “Whereas scientific premise pertains to supporting data, scientific rigor pertains to the proposed research (statistical procedures, data analysis, precision, subject inclusions and exclusion criteria, etc.). Different research fields may have different standards or best practices for scientific rigor.”

- Addressed in review of **Approach** criterion for R grants and **Research Plan** in K
Rigor and Transparency

- Consideration of Relevant Biological Variables: critical factors affecting health or disease in vertebrate animals or human subjects
  - The NIH Policy applies broadly to all relevant biological variables, for example sex, age, source, weight, and genetic strain.
- Consideration of sex as a biological variable required with human or animal studies
- Strong justification required for using only single sex
- Cost and no known sex differences insufficient
- Other important biological variables may be considered
Rigor and Transparency

- **Plan for Resource Authentication:** key biological and/or chemical resources are those that may differ from lab to lab or over time, could influence the research data, and are integral to the proposed research.
  - Examples include cell lines, specialty chemicals, antibodies, and other biologics, not standard laboratory reagents.
  - The plan should be brief (one page or less for the entire plan), and should not include authentication data. The plan may reflect existing guidelines for some resources or the need for a community to develop a plan for other resources.

- Review of this attachment will occur after scoring; comments on key resource authentication should not affect scores.
What about NSF grants?

A very different beast!

- Criteria are Intellectual Merit and Broader Impacts
- The goal to tell a logical, compelling, accurate story is still the same
- At the end of the day you have to convince the reader what you are proposing is more important to do than 90% of the proposals they are reading
- Recent feedback from NSF Program Officer that logic flow is the same as we teach for NIH grants
Online Tools for Grant Writing

Developed by communications expert who worked with us for 18 months – Karl Keller

Animated PowerPoint presentations with audio – each 15 minutes or less

Vivid display of the patterns that reviewers see and expect to see in grant judged as high quality and fundable

Classic cultural capital which funded PIs have acquired but seldom could articulate what they are doing or why

http://www.northwestern.edu/climb/resources/written-communication/index.html
The next paragraph takes up other components, with qualifications addressed after aims.

Specific Aims: The long-term goal of this research project is to identify the optimal dose and schedule of administration of drugs active against influenza viruses that will prevent and/or cure people with influenza without causing the emergence of resistant viruses. The adamantanes and neuraminidase inhibitors have been used for the prevention and/or treatment of influenza. However, they often fail because treatment with these drugs leads to the emergence of resistant viruses in the treated population.

Adamantanes have historically been used in the treatment and prevention of influenza A virus infections (1). Recently, viruses that are resistant to these inexpensive drugs have emerged, rendering them less useful for the therapy of influenza (2, 3). Neuraminidase inhibitors represent a new class of agents for use against type A and type B influenza virus infections (1). While shown to be effective, there have been instances of emergence of resistance or reduced sensitivity during therapy with neuraminidase inhibitors (4-6). This has been seen especially in children where high clearances for these agents in general and oseltamivir in specific are the norm (5).

The hollow fiber infection model (HFIM) system has been used to determine the optimal dose and schedule of administration of antibacterial, antifungal and antiviral compounds for use in the treatment of individuals infected with bacteria, fungi, and viruses (7-16). We propose to use the HFIM system to study the effects of amantadine and the neuraminidase inhibitor, oseltamivir carboxylate, on the replication of influenza viruses and to identify the pharmacodynamically-linked variables for these antiviral drugs, alone and in combination, with respect to inhibition of virus replication. We also propose to identify whether a different pharmacodynamically-linked variable is present for suppression of emergence of resistance. We hypothesize that the HFIM system can be used to provide information on resistance selection in humans and that the HFIM system can be used to determine the dose and administration schedule of antiviral compounds and combinations of antiviral compounds that will inhibit the replication of influenza viruses while preventing the emergence of resistance.

Our research strategy involves a multifaceted, translational collaboration designed to optimize the move from research discovery to clinical application. The collaborators in this activity include a nonprofit research institute (Orway Research Institute, Albany, NY), a non-profit genomics research institute (Translational Genomics Research Institute, Flagstaff, AZ), and a private biotech company (Adamas Pharmaceuticals, Inc, Emeryville, CA). This strategy has proven successful in other activities including a current and ongoing research project involving the above partners.
So, let’s look at the two rhetorical patterns, side by side—similar components different sequence

- General context & significance
  - Narrowing context
    - Our research contribution
  - Complication
    - Long-term goal
      - Specific & narrow research goal
        - Hypothesis explicitly stated
        - Summary of research—path to hypothesis
          - Addition to specific research goal
          - Qualifications stressed
  - Long-term goal
    - General context & significance
      - General complication
        - Narrowing context
          - Narrowing/specific complication
          - Summary of research—path to hypothesis
            - Specific & narrow research goal
              - Hypothesis explicitly stated
              - Qualifications stressed
Your challenge is to identify these components for your research, arrange them logically; this template can help

- **General context & significance**: What is “big picture” for research? Why is it important?
- **Narrowing context**: What is known and accepted in your research area?
- **Your research contribution**: Has your previous work contributed? How?
- **Complication**: What is the problem, roadblock, the unknown?
- **Long-term goal**: What final “big result” will research will help achieve?
- **Specific goal of this research**: What is “specific narrow goal” of this research?
- **Summary of research—path to hypothesis**: How does previous research lead to hypothesis?
- **Hypothesis**: What do you believe to be the answer to the complication?
- **Qualifications stressed**: What makes you the right person to undertake this research?
K Awards – the K Kiosk

http://grants.nih.gov/training/careerdevelopmentawards.htm

Be SURE to determine any unique requirements or idiosyncrasies for K awards at the Institute you are applying to - talk to the Program Official well in advance.

Read the instructions very carefully.

ALL sections of the application must be strong – any one that is weak is likely to drag down the rest.

A unique blend of capturing how great you are but how you still need extended support to be greater.

Never view a K award as an ‘end’, always as a means to an end – your successful independent career.

Critical to make clear the thrust of R01 proposal you likely would submit by the start of last year (up to 5 years).
K08 Scored Review Criteria

Mentored Clinical Scientist Research Career Development Award


**Candidate**

Does the candidate have the potential to develop as an independent and productive researcher?

Are the candidate's prior training and research experience appropriate for this award?

Is the candidate’s academic, clinical (if relevant), and research record of high quality?

Is there evidence of the candidate’s commitment to meeting the program objectives to become an independent investigator?

Do the letters of reference address the above review criteria, and do they provide evidence that the candidate has a high potential for becoming an independent investigator?
K08 Scored Review Criteria

Career Development Plan/Career Goals and Objectives

What is the likelihood that the plan will contribute substantially to the scientific development of the candidate and lead to scientific independence?

Are the candidate's prior training and research experience appropriate for this award?

Are the content, scope, phasing, and duration of the career development plan appropriate when considered in the context of prior training/research experience and the stated training and research objectives for achieving research independence?

Are there adequate plans for monitoring and evaluating the candidate’s research and career development progress?
K08 Scored Review Criteria

Research Plan

Are the proposed research question, design, and methodology of significant scientific and technical merit?

Is the research plan relevant to the candidate’s research career objectives?

Is the research plan appropriate to the candidate’s stage of research development and as a vehicle for developing the research skills described in the career development plan?
K08 Scored Review Criteria

Mentor(s), Co-Mentor(s), Consultant(s), Collaborator(s)

Are the mentor's research qualifications in the area of the proposed research appropriate?

Do(es) the mentor(s) adequately address the candidate’s potential and his/her strengths and areas needing improvement? Is there adequate description of the quality and extent of the mentor’s proposed role in providing guidance and advice to the candidate?

Is the mentor’s description of the elements of the research career development activities, including formal course work adequate?

Is there evidence of the mentor’s, consultant’s and/or collaborator’s previous experience in fostering the development of independent investigators?

Is there evidence of the mentor’s current research productivity and peer-reviewed support?

Is active/pending support for the proposed research project appropriate and adequate?

Are there adequate plans for monitoring and evaluating the career development awardee’s progress toward independence?
K08 Scored Review Criteria

Environment & Institutional Commitment to the Candidate

Is there clear commitment of the sponsoring institution to ensure that the required minimum of the candidate’s effort will be devoted directly to the research described in the application, with the remaining percent effort being devoted to an appropriate balance of research, teaching, administrative, and clinical responsibilities?

Is the institutional commitment to the career development of the candidate appropriately strong?

Are the research facilities, resources and training opportunities, including faculty capable of productive collaboration with the candidate, adequate and appropriate?

Is the environment for scientific and professional development of the candidate of high quality?

Is there assurance that the institution intends the candidate to be an integral part of its research program as an independent investigator?
K Award Sections and Page Limits

Specific Aims – 1 page

• Differences of opinion on whether to include career development aims as well as research aims but research should predominate

First 3 items of Candidate Information and Research Strategy – 12 pages – typically 50:50 career development and research

• Candidates Background, Career Goals and Objectives, Career Development Training Activities During the Award Period

Training in Responsible Conduct of Research – 1 page

Statements by Mentor, Co-Mentor, Consultants, Contributors – 6 pages

Description of Institutional Environment – 1 page

Institutional Commitment to Candidate’s Research Career Development – 4 pages

Biographical Sketch – 4 pages
Why is grant writing so hard to learn?

In the past has not been seen as a concrete, teachable skill.

Informal mentoring as a process is very idiosyncratic with high degree of variability in skills taught.

Often tacit (or even explicit) belief among some scientists that being able to figure it out by yourself is one of the determinants of whether or not you ‘belong’ in the Community.

All of our approaches and research are challenge these myths and assumptions.
Faculty Grant Writers Groups – began in 2008

Began developing approach in mid-1990s
Every 4 months – “Whose writing a proposal?”
Mimics closely what we are doing here
Everyone comes with paper copy of Specific Aims page, or research questions, hypotheses if just getting started
In real time, read and discuss – I model talking through what my brain is hearing from what I read – others engage too
Each week refine and revise questions, hypotheses, aims, aims page
Move on to Significance, Innovation, other sections of F and K
Especially effective done early during writing
Have added recording of oral interchange – moving more toward using oral processing methods
This is what we will be doing over the next ~3 months
Grant Writers Groups - continued

May go on to Approach but most often these are beyond the expertise of the group, but not always

Still requires input of scientific mentors, and other mentors for K, but focuses that time on the science while we develop writing skills and give fresh eyes to improve writing

Audio recording of discussion BIG improvement - captures thinking and discussion which otherwise often lost
What is happening during writers groups?

Development or refinement of scientific thinking, ability to define research questions, hypotheses,
Scientific writing skills – down to level of sentence construction
Viewing proposal writing as a highly refined stylistic pattern – including rhetorical patterns
Detailed knowledge of what goes into each section and why
Developing ability to ‘think like a reviewer’
Demystification – grant writing is a very learnable skill
Simulation of grant review process and realities
Positive peer group – all in it together
Career development guidance – sometimes harsh reality check
Some realize it is not for them – often a positive outcome!
But can’t salvage weak science!
Participants so far…

250+ different people since 2008 – also many repeats
Roughly 30-50% stay the course in each group
   Some realize they need more time, preliminary data, pubs
Many referrals from colleague to colleague
Faculty mentors referring Fellows and junior faculty to the group
As could be expected, difference of style and content between
group and mentors pop up – good teaching tool, careful not
to be dogmatic or proscriptive about only one way to write
At least 55 proposals funded to people who have been in groups – many pending and in various stages of resubmission
3 perfect 10s on K and R03 proposals
High number of responses indicate perception of substantial value
Have replicated with many virtual groups through AAMC and NRMN
Take-Home Messages

Writing research proposals is an invaluable element of high quality research

Writing research grants is a teachable, learnable skill

• Often not approached as such because of the focus of research training on informal mentoring

• Effective grant writers (i.e. mentors) often can’t explain or deconstruct why they write the way they do and why it works

The ability to write and sound like what reviewers expect is a central ingredient of being judged as a legitimate member of the research community – strong social underpinnings

It is extremely difficult to become a skilled writer by yourself – look to colleagues and groups as invaluable resources
More Take-Home Messages

Get feedback early and often on small pieces of writing
Recognize you will get different perspectives from different kinds of readers
See if you can get people to ‘think out loud’ as they read – reveal what they are thinking as they read
Feedback on a full proposal is great but requires a lot of time – be sure to have the right people do it
Don’t let writing proposals hold you back!