# “How I Did It” Extramural Funding Applications

Saieesh Rao

4/10/2025

# Awards I applied for and secured

- **F32 Ruth Lillian Kirschstein National Research Service Award from the Agency for Healthcare Research and Quality (AHRQ F32)**
  - $174,497 over two years

- Accepts applications in April, August, and December
- Allows 1 resubmission attempt if rejected
- Number of awards limited by federal budget allocation
- No interview

- **American College of Surgeons Resident Research Scholarship (ACS)**
  - $60,000 over two years

- One submission deadline annually in September
- 5 awards per year
- No interview

- **Association for Academic Surgery / AAS Foundation Trainee Research Fellowship Award (AAS)**
  - $30,000 over one year

- One submission deadline annually in August
- 4 awards per year, one per research category
- Has an interview

# Disclaimers

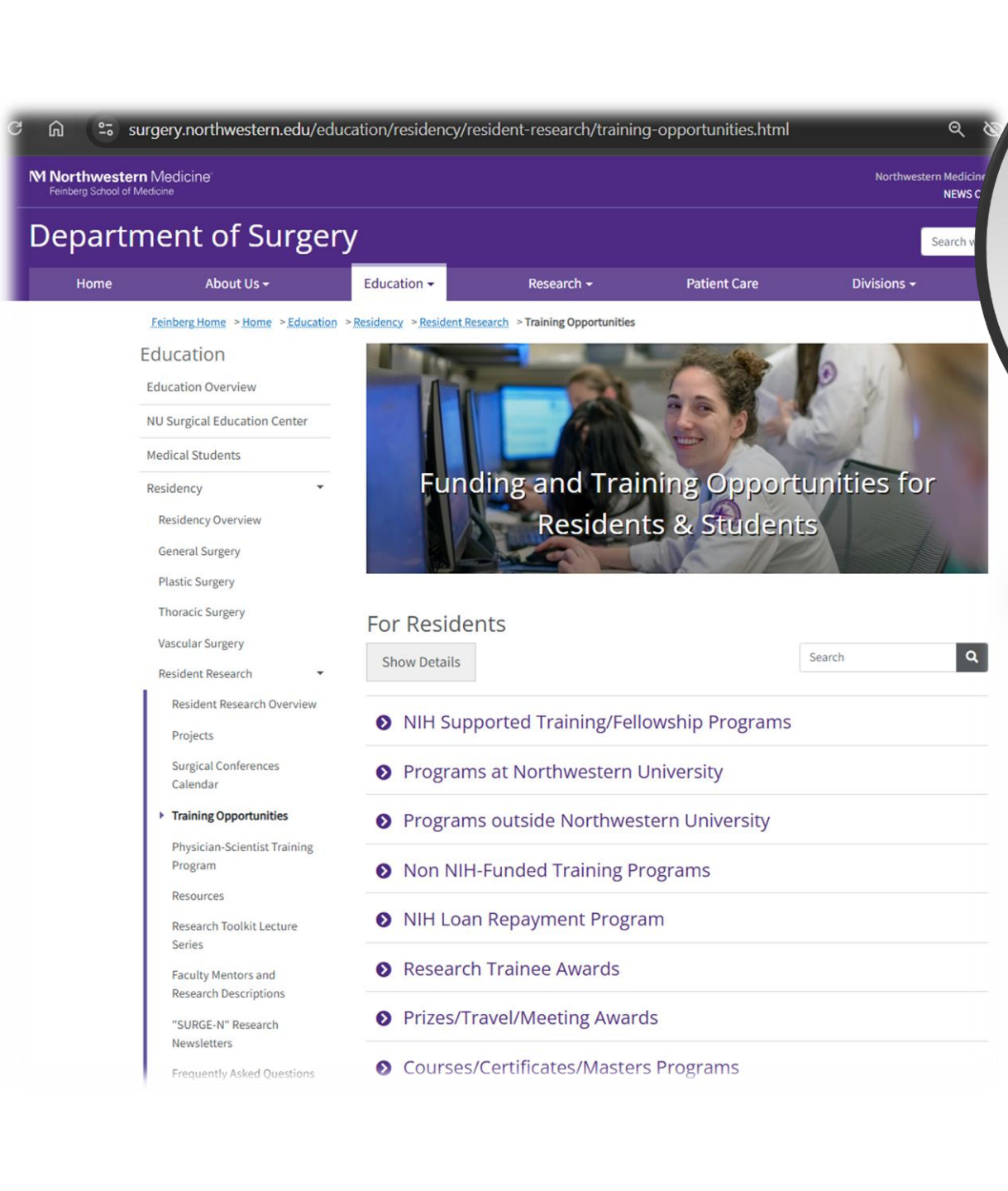
- This presentation represents one person's perspective
- This presentation combines anecdote, objective fact, and opinion
- I will make strong recommendations based on my experience, YMMV
- The eventual success of the applications is in larger part due to support from mentors and assistance from previous applicants
- The federal funding environment is in flux and may make my strategy less applicable in the future

# The Most Important Thing

# TIMELINE

- Timeline, timeline, timeline
- If you are very serious about getting **individual award** funding, start thinking about it at end of intern year
  - "The best time to start was back then… the next best time is now"
  - April PGY2 is still doable!
- Other training grants (T32, R38) available to Northwestern residents are applied for in third year
  - These are your backups, not the goal
- What does the timeline look like, actually?
- What is the strategy to maximize your efficiency applying for awards?

# How to Identify Awards




# List of Awards on the Website

## NIH Supported Training/Fellowship Programs

- NIH Ruth L. Kirschstein National Research Service Award (NRSA) Individual Postdoctoral Fellowship (F32)

## Programs at Northwestern University

- Chicago Kidney Urology Hematology network FOR city-Wide reseArch tRaining and career Development (Chicago KUH FORWARD) (Deadline - Rolling basis until slots are filled)
- NQUIRES NCI Resident Research Opportunity in Surgical Oncology (PDF) (NIH/NCI R38) (Deadline 9/29/23)
- NQUIRES Resident Research Opportunity in Surgical Oncology (PDF) (NIH/NCI T32) (Deadline 9/29/23)
- Northwestern University Minority Health Disparities Research Training Program (NIH/NIMDH T37)
- TL1 - Multidisciplinary Training Program in Child and Adolescent Health
- Vascular Surgery Scientist Training Program (NIH/NHLBI T32) (Latest application date 3/1/24)
- Transplant Surgery Scientist Training Program
- NU School of Professional Studies Advanced Graduate Certificates (Including Health Informatics and Artificial Intelligence)
- NU-THRIVE: Postdoctoral T32 Fellowship in Translational Science, HIV, and Sexual and Gender Minority Health
- The University of Chicago and Northwestern University Postdoctoral Health Services Research Program Postdoctoral Fellowship
- Robert J. Havey, MD Institute for Global Health

## Programs outside Northwestern University

- The Advanced Immunobiology T32 Training Program (AITP) at Duke University (Deadline 2/1/24)
- Training of Academic Surgical Oncologists T32 Training Program at MD Anderson Cancer Center
- T32 NIH Training Grant Position at Boston University (DOCX)
- University of Arizona Aerospace Medicine and Surgery Fellowship

## Non NIH-Funded Training Programs

- American College of Surgeon Clinical Scholars in Residence
- American College of Surgeons Scholarships
- National Numbered Surgical Education Trials Group Research Fellowship (2 years)
- Howard Hughes Medical Institute Hanna H. Gray Fellows Program (Deadline 12/1/23; Internal Deadline 11/27/23)

## NIH Loan Repayment Program

- NIH Loan Repayment Program (Deadline 11/21/24)

## Research Trainee Awards

- Steven J. Stryker, M.D., Gastrointestinal Surgery Research and Education Endowment Deadline 3/1/24
- Association of Academic Surgeons (AAS)/AAS Foundation Trainee Research Awards (in areas of basic science, clinical, and education) (Deadline 8/21/23; internal deadline 8/9/23)
- AATS David J. Sugarbaker Surgical Resident Investigator Award (Deadline 12/1/23; internal deadline 11/20/23)
- AATS Foundation Programs (Search "Residents" for full list)(Deadline 12/1/23; internal deadline 11/20/23)
- American Association for Cancer Research (many opportunities)
- American College of Surgeons Resident Research Scholarships (Deadline 9/15/23; internal deadline 9/5/23)
- American Heart Association Postdoctoral Fellowship (Deadline 9/7/23; internal deadline 8/28/23)
- American Society of Transplant Surgeons Jon Fryer Resident Research Scholarship Deadline TBA
- American Society of Transplant Surgeons Veloxis Fellowship in Transplantation Deadline TBA
- The MacLean Center for Clinical Medical Ethics at the University of Chicago (Deadline 1/15/24; internal deadline 1/4/24)
- Nina Starr Braunwald Research Award (Thoracic Surgery Foundation) (Deadline 9/15/23; internal deadline 9/5/23)
- Society of American Gastrointestinal and Endoscopic Surgeons (Deadline 10/1/23; internal deadline 9/19/23)
- Society of University Surgeons Resident Research Scholar Award (Deadline 6/28/24; internal deadline 6/18/24)
- Surgical Outcomes Club Michael Zinner HSR Fellowship (Deadline May 2024)
- Thoracic Surgery Foundation Resident Research Fellowship (Deadline 9/15/23; internal deadline 9/5/23)
- VA Chief Resident in Quality and Patient Safety Program (CRQS)
- Vascular and Endovascular Surgical Society/Medtronic Vascular Resident Research Award (Deadline 10/6/23; internal deadline 9/22/23)

## Prizes/Travel/Meeting Awards

- 2023 AMA Research Challenge
- AOA Postgraduate Fellowship (for 2K) (Deadline 5/28/24; Internal deadline is 5/28/24)
- Midwestern Vascular Surgical Society travel scholarship
- Midwestern Vascular Surgical Society Trainee Awards
- The Society of Asian Academic Surgeons Foundation Academic Surgical Congress Research Award (Deadline 8/6/23; internal deadline 7/26/23)

**Others not shown**:

- ASCRS (colorectal) Resident Research Fellowship
- Am Assoc Thoracic Surgery
- Plastic Surgery Foundation
- Probably more…

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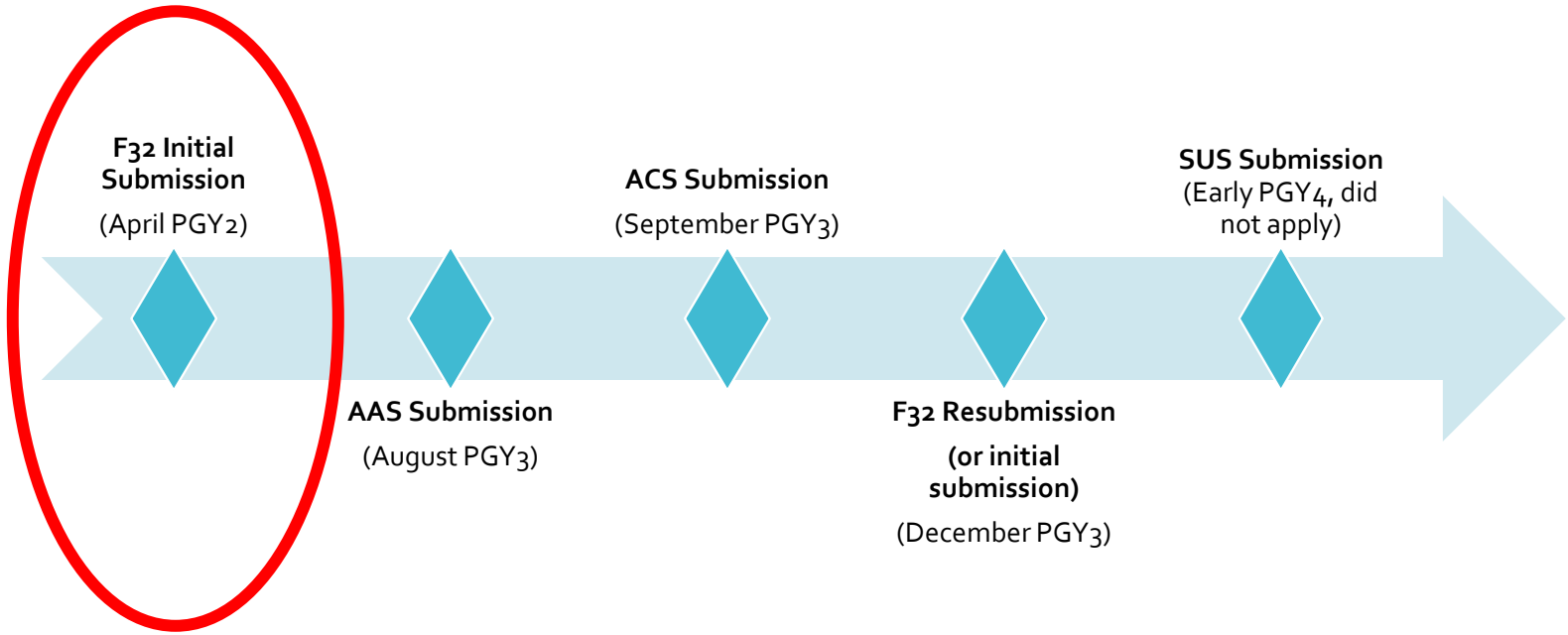
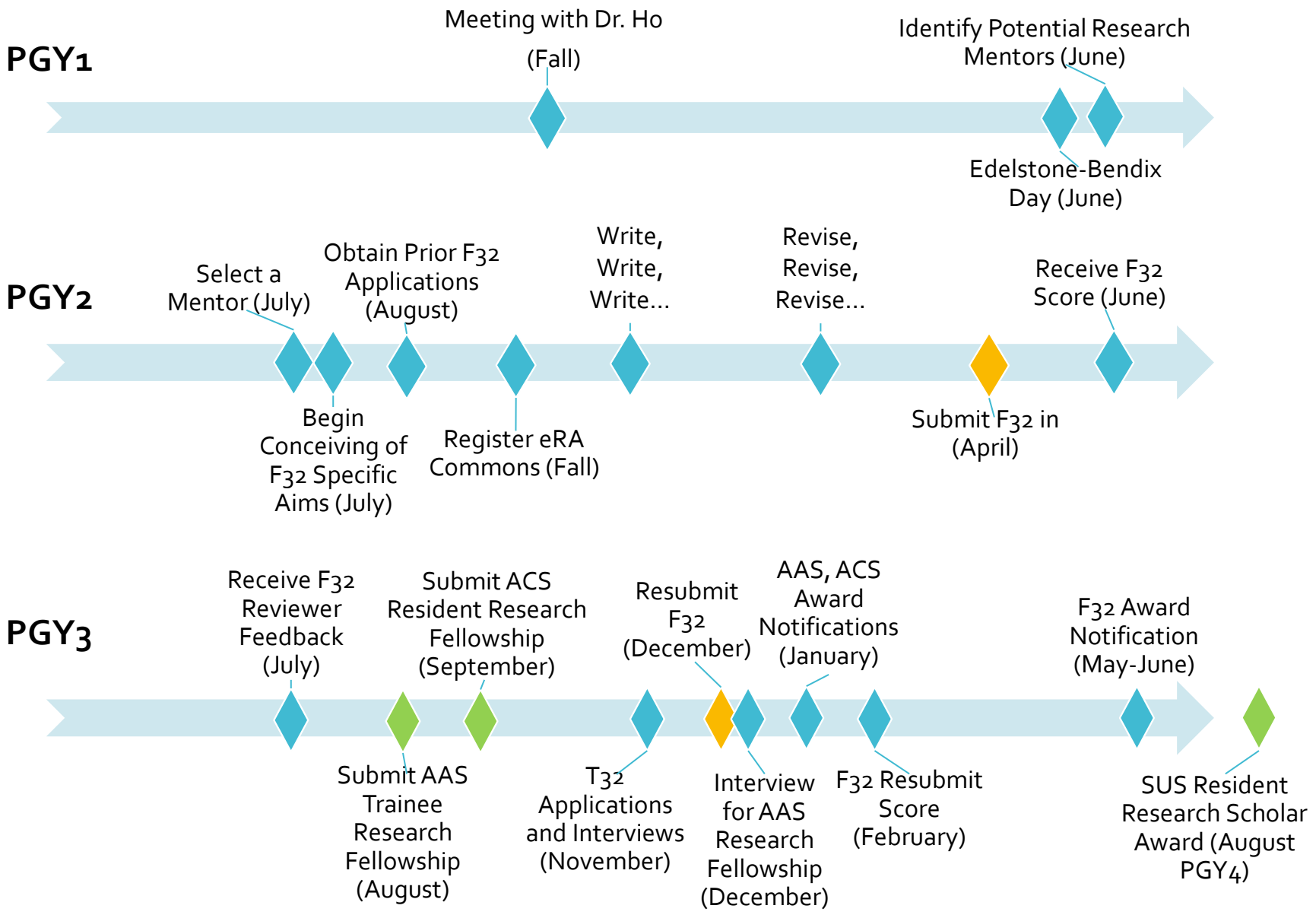
## Courses/Certificates/Masters Programs

- ACS Leadership and Advocacy Summit (April)
- ACS Residents as Teachers and Leaders (March)
- Artificial Intelligence at Northwestern
- FSM Center for Education in Health Sciences Master of Science in HSOR
- Institute of Image-Guided Surgery (IHU Strasbourg) Diploma Program
- McGaw Medical Education Clinical Scholars Program (Programs in Bioethics, Global Health, Health Equity and Advocacy, and Medical Education)
- NU Center for Leadership Fellowship in Leadership
- NUCATS Master of Science in Clinical Investigation
- School of Professional Studies Artificial Intelligence Certificate Program

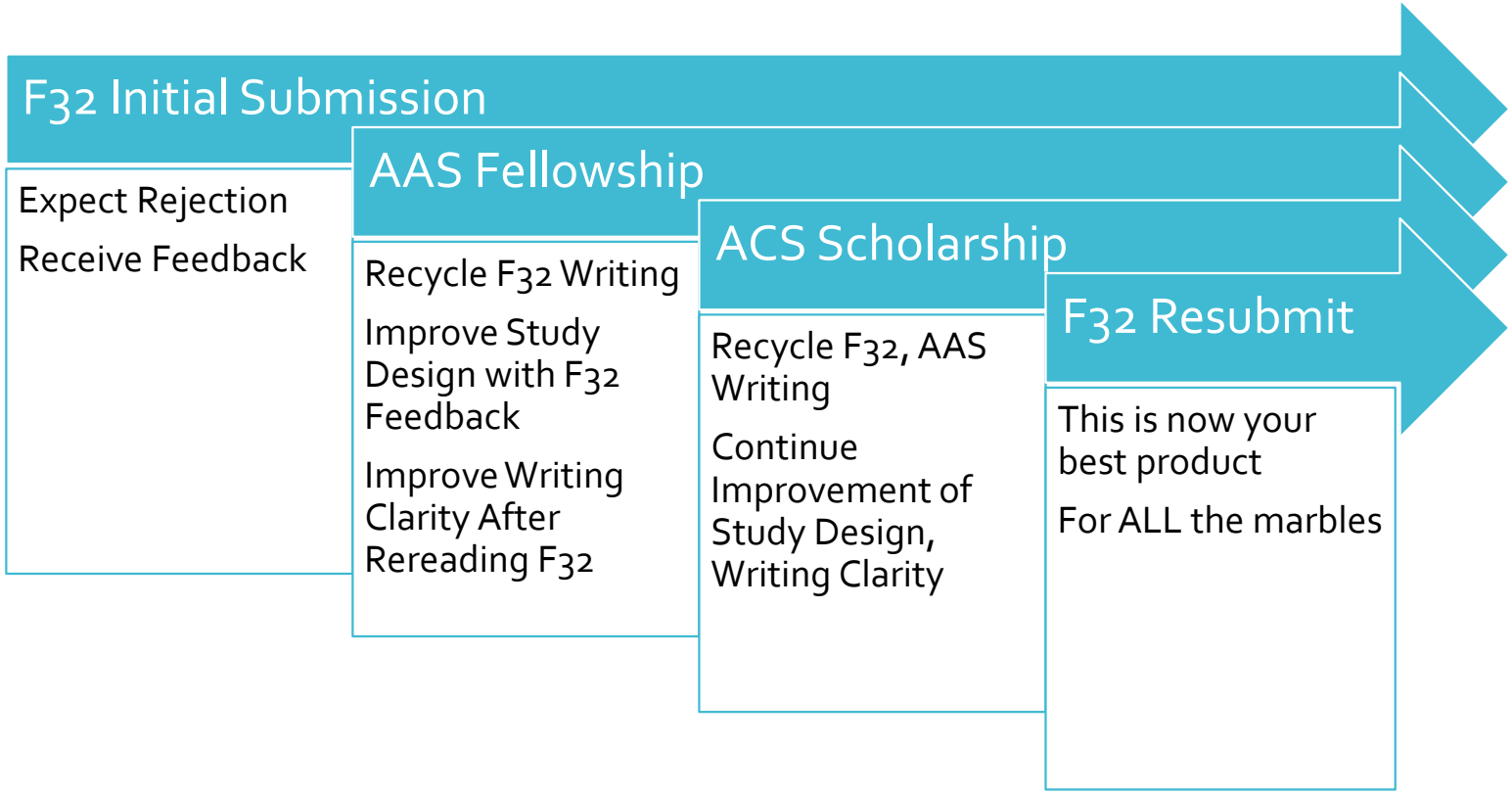
# The Timeline



# The Timeline



# The Strategy:
## Make the most of the opportunity to resubmit your F32




- The latest you can submit an F32 in time to start research years with funding is December PGY3
- Working backwards gives us the April PGY2 deadline for your initial F32 submission, so you can resubmit in December PGY3
- This conveniently provides the window to recycle the initial F32 submission for other award applications at the start of PGY3
- Not shown: Society of University Surgeons (SUS) Resident Research Scholar Award applications are due in **August PGY4** if you don't get any of these funds

# Comparison of Award Submission Requirements

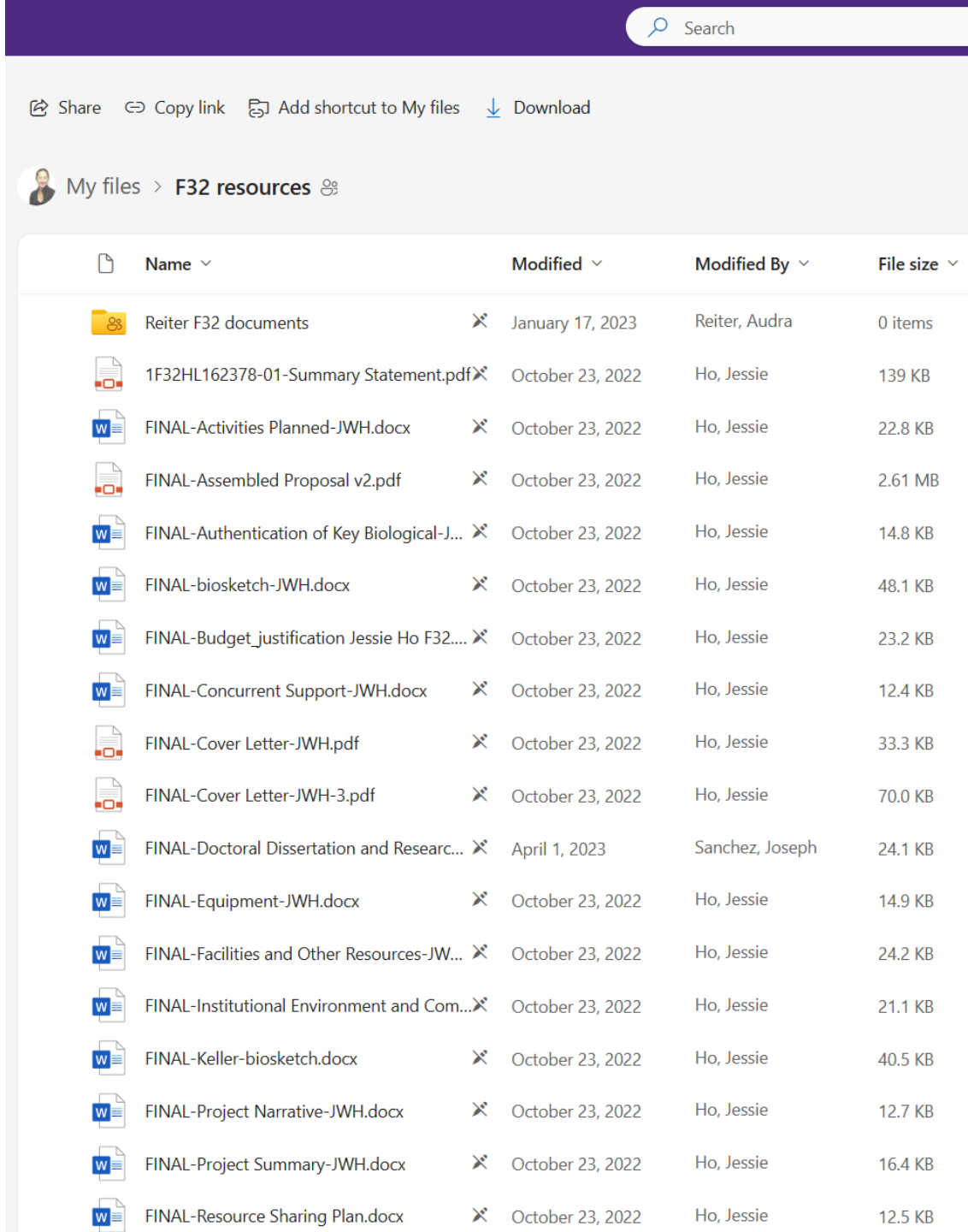
The society awards can be written entirely with F32 materials

Remember to modify letters, cover pages for specific awards

| | F32 | ACS | AAS |
|---|---|---|---|
| Cover Letter | 1 page | 1 page introducing the applicant, career objectives, training plan | 1 page |
| Introduction | 1 page (resubmission only) | | |
| Project Summary/Abstract | 1 page summarizing specific aims, training plan, and environment | | 1 page |
| Project Narrative | 2-3 sentence summary | | |
| Specific Aims | 1 page | 1 page | 5 pages |
| Research Strategy | 6 pages | 3 pages | |
| References Bibliography | No Limit | 1 page | |
| Background & Goals of Fellowship Training | 6 pages | | |
| Sponsor / Co-Sponsor Statements | 6 pages | | |
| Letters of Support | 6 pages | | |
| Letters of Reference | At least 3, no more than 5 | 1 chair letter, 1 research PI letter | 1 chair letter, 1 research PI letter |
| CV / Biosketch | Applicant, Sponsors, Co-Sponsors | No | Applicant, Research PI |
| Facilities & Other Resources | No Limit | | |
| Equipment | No Limit | | |
| Human Subjects Protections | 8 subcategories, <1 page each, however extensive PHS Human Subjects and Clinical Trials Form | | |
| Respective Contributions | 1 page | | |
| Selection of Sponsor and Institution | 1 page | | |
| Responsible Conduct of Research | 1 page | | |
| Institutional Environment and Commitment to Training | 2 pages | | |
| Budget and Justification | No Limit | 1 page | 1 page |

# Using Peer Materials

- Jessie shared her final F32 submission materials as well as those of prior applicants (successful and not)
- Much of the language was recyclable
- There were differences between basic science vs. health services research
  - Particularly regarding facilities, equipment, selection of institution given my focus was different
- Dr. Ho has collected these in a central repository for internal use

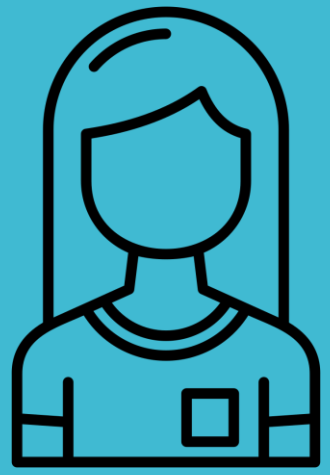


# Biggest Challenges for F32

- **Obvious:**
  - Clinical residency remains time consuming and the priority
- **Less Obvious:**
  - The long timeline in mid-PGY2 is deceptive
    - It is NOT a lot of time and it is NOT too early
  - YOU are the primary driver of the proposal
    - You collaborate with your mentor, but YOU are inventing the Specific Aims and Research Strategy
    - This sometimes means making up the research strategy as you go
    - Easy to get stuck or feel you are in quicksand because the amount of work is paralyzing
  - YOU likely will ghostwrite all sponsor, co-sponsor, and reference letters
  - Iterative revisions can be demoralizing
    - See-saw been nitpicking during some weeks and major revisions of research strategy during other weeks
  - The proposal needs multiple sponsors with different expertise
    - You need to find sponsors and obtain their consent; your mentor can help assemble a sponsorship team
  - The training plan is more important than the actual project
    - F32 is a training grant, and the project is a vehicle for training you in research
    - Your proposal will be rejected for a stellar project and inadequate training plan

# My Experience

- The **initial F32 submission** required effort which felt overly demanding as a clinical resident
- Despite starting early, it was easy to defer working on non-essential grant writing in favor of clinical residency expectations
- Having prior F32 applications as a reference led to a false sense of security
- **AAS and ACS** applications were significantly easier having already put the thought into the F32 and recycling much of the language
- Adapting the F32 application to the reduced page requirements for AAS and ACS was still laborious
- The **F32 resubmission** was started over a month in advance and still required excessive time wordsmithing, formatting, and crafting a new training plan from scratch
- Input from my mentor and co-sponsors greatly improved the application, but at the same time created more work from incorporating their feedback
- That said, the amount of funding has made research life much easier given increased funding for conference travel, analyst support, etc.
- My experience does not have to be yours
- Future grant applications now appear less daunting – I have muscle memory on how to put together a grant and know what level of effort is necessary, so I can plan better



# Testimonial

Anonymous PGY5 #1

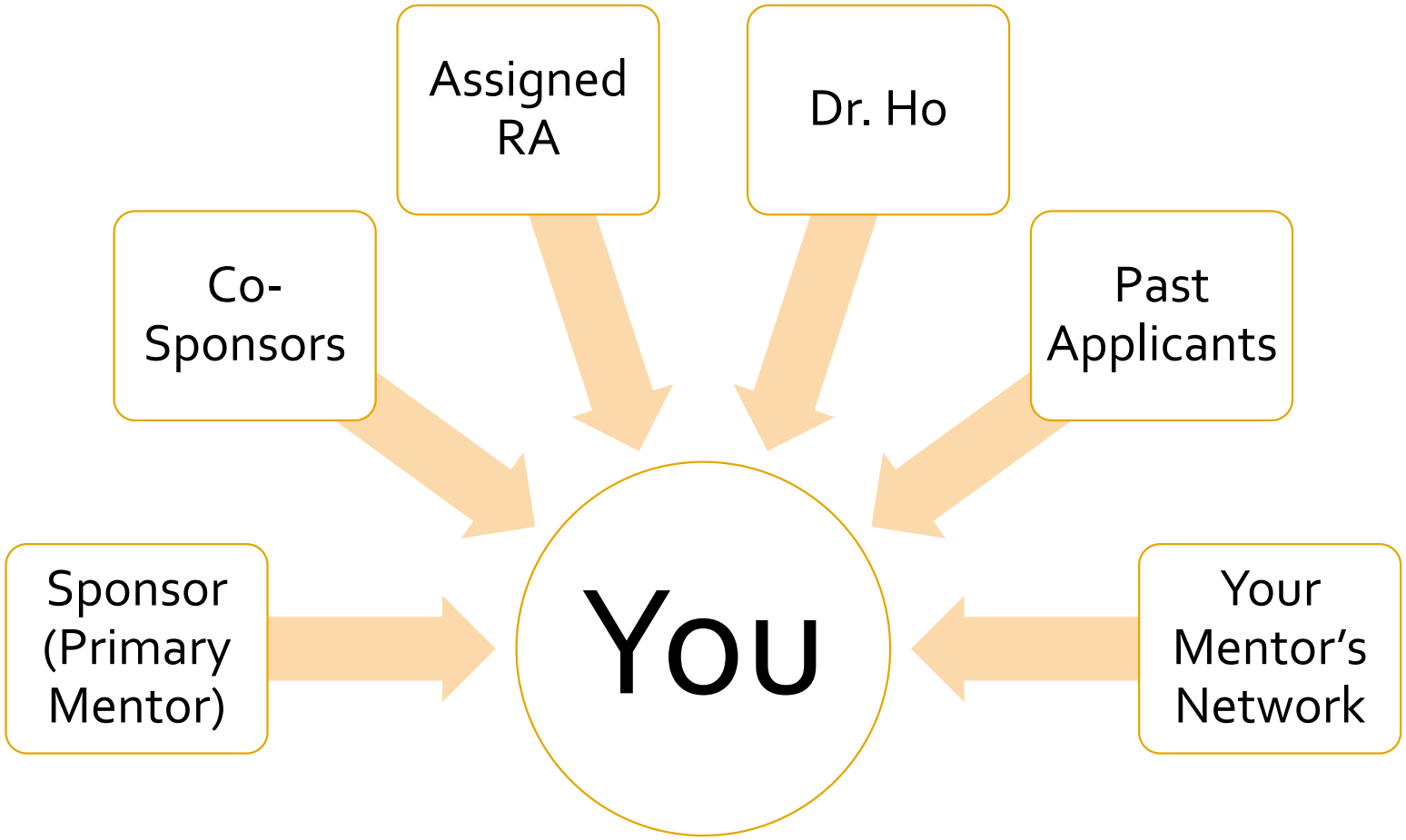
- *"I think my year was honestly a little weird with [finding research funding] …because **we all were so late in finding opportunities and missed a lot of deadlines**"*
- *"I think at the time I wish I knew **1.** What options there were, and what the due dates were **2.** Exactly how to access the grant advising services at NM and if we HAD to use them (since usually means needs to submit [weeks] earlier) and **3.** How many to apply for"*
- *"I think what happened to me was that **I had a sense I wanted to apply for an F32 and the loan forgiveness** but **didn't have a project** identified in time and **couldn't pull myself together in 3 months**"*
- *"There was sorta like a sense like, you should do this, and really no guidance except just winging it. Like **I wish I had a timeline** but I feel like since then Dr. Ho has shared some of that stuff so hopefully that's not a problem anymore"*

# Testimonial

Anonymous PGY5 #2

- *"… I would've been more successful **if I had started sooner** and had **acquired a mentor sooner** also."*
- *"You **can't really write one of these things within 3 months** like I tried to do."*

# You Have Support



# Finding a Mentor

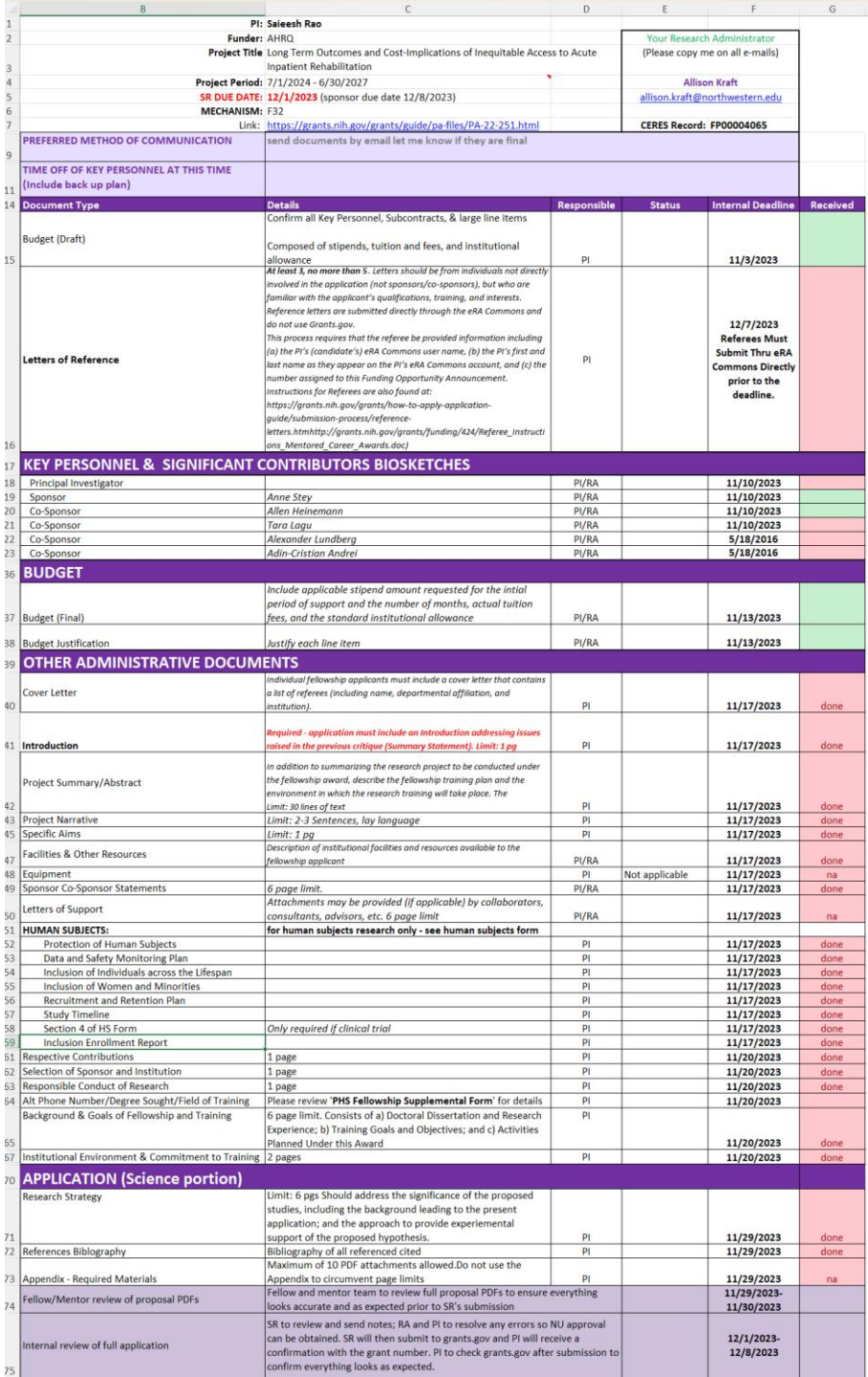
- Ideally someone with a track record of supporting research residents
- Should be someone you envision yourself getting along with
- Ask prior research residents for their experiences with their mentors
  - Biggest complaint: lack of mentor responsiveness
- **Two approaches:**
  - Choose mentor for their subspeciality:
    - Pros: they can introduce you to colleagues at conferences, you demonstrate interest in the field, you will have much deeper exposure to field which shows on the interview trail
    - Cons: if you change your subspeciality interest (not uncommon), these benefits evaporate somewhat, you might be doing projects you are not really enthused about (clinical research when you want basic science, etc.)
  - Choose mentor because of their research methods:
    - Pros: what you learn will be applicable no matter your future subspeciality, you can brand yourself as a methods expert ("qualitative methods", "basic science", "health economics" etc.) and how that relates to your career goals
    - Cons: less opportunity to network with people in your chosen field, you will have to do some outside work to demonstrate interest if important for your eventual subspeciality (publications, conferences, etc.)
- Faculty at conferences insist productivity and project ownership >> subspeciality focus, but there's likely a balance

# Finding a Mentor

- My advice: pick the mentor for their **research methods** because you will be happy regardless
  - Double whammy if you change specialty interest AND don't like basic science / statistics / qualitative interviews, etc.
  - Methods are 90% of your time (what your day-to-day looks like)
  - You can always be a methods expert and apply them to projects in your new field
- People change their minds during research years
  - Research year experiences will convince people for or against certain specialties
  - Research year lifestyle, family events, etc. also play a role
- You can pick up additional projects / mentors during research years, but you need to find a mentor early to start applying for grants

# RA Checklist & Internal Deadlines

- Your **research assistant (RA)** is a dedicated expert in grant submissions employed by Northwestern University
- Your RA will be the same as that of your primary mentor (sponsor)
- They will create your account on **eRA Commons** and make a checklist of submission materials for your specific funding opportunity
- They will demand all administrative submission materials to be given **two weeks early** before the funder's submission deadline
  - **One week early** for the remainder (scientific content like specific aims, research strategy, goals and training)
  - This is practically a big deal for your timeline as time runs short



| | |
|---|---|
| **PI:** | **Saieesh Rao** |
| **Funder:** | AHRQ |
| **Project Title** | Long Term Outcomes and Cost-Implications of Inequitable Access to Acute Inpatient Rehabilitation |
| **Project Period:** | 7/1/2024 - 6/30/2027 |
| **SR DUE DATE:** | **12/1/2023** (sponsor due date 12/8/2023) |
| **MECHANISM:** | F32 |
| Link: | https://grants.nih.gov/grants/guide/pa-files/PA-22-251.html |

Your Research Administrator
(Please copy me on all e-mails)
**Allison Kraft**
allison.kraft@northwestern.edu
**CERES Record: FP00004065**

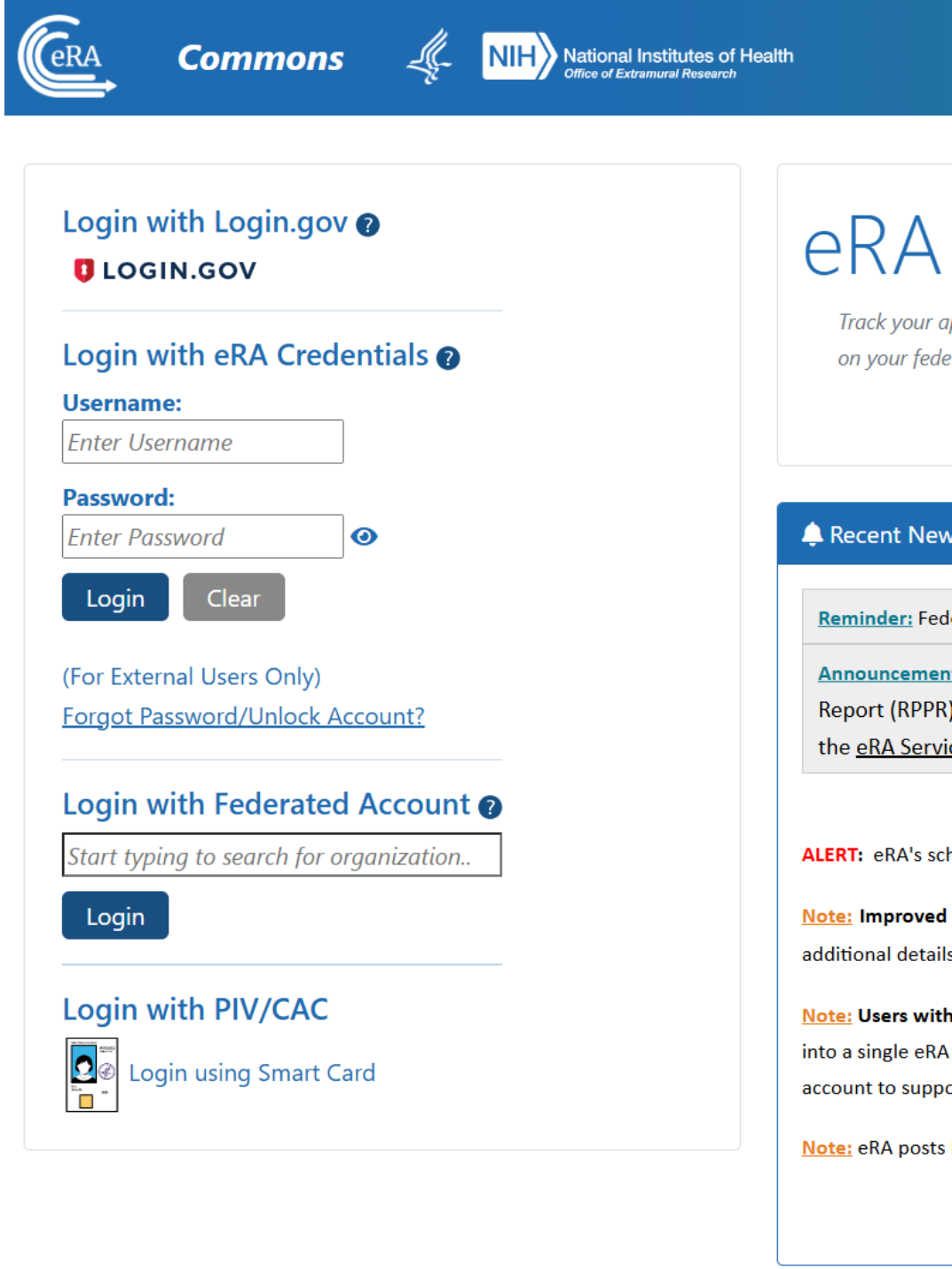
**PREFERRED METHOD OF COMMUNICATION** — send documents by email let me know if they are final

**TIME OFF OF KEY PERSONNEL AT THIS TIME (Include back up plan)**

| Document Type | Details | Responsible | Status | Internal Deadline | Received |
|---|---|---|---|---|---|
| Budget (Draft) | Confirm all Key Personnel, Subcontracts, & large line items<br>Composed of stipends, tuition and fees, and institutional allowance | PI | | 11/3/2023 | |
| **Letters of Reference** | ***At least 3, no more than 5**. Letters should be from individuals not directly involved in the application (not sponsors/co-sponsors), but who are familiar with the applicant's qualifications, training, and interests. Reference letters are submitted directly through the eRA Commons and do not use Grants.gov. This process requires that the referee be provided information including (a) the PI's (candidate's) eRA Commons user name, (b) the PI's first and last name as they appear on the PI's eRA Commons account, and (c) the number assigned to this Funding Opportunity Announcement. Instructions for Referees are also found at: https://grants.nih.gov/grants/how-to-apply-application-guide/submission-process/reference-letters.htmhttp://grants.nih.gov/grants/funding/424/Referee_Instructions_Mentored_Career_Awards.doc)* | PI | | **12/7/2023 Referees Must Submit Thru eRA Commons Directly prior to the deadline.** | |
| **KEY PERSONNEL & SIGNIFICANT CONTRIBUTORS BIOSKETCHES** | | | | | |
| Principal Investigator | | PI/RA | | 11/10/2023 | |
| Sponsor | *Anne Stey* | PI/RA | | 11/10/2023 | |
| Co-Sponsor | *Allen Heinemann* | PI/RA | | 11/10/2023 | |
| Co-Sponsor | *Tara Lagu* | PI/RA | | 11/10/2023 | |
| Co-Sponsor | *Alexander Lundberg* | PI/RA | | 5/18/2016 | |
| Co-Sponsor | *Adin-Cristian Andrei* | PI/RA | | 5/18/2016 | |
| **BUDGET** | | | | | |
| Budget (Final) | *Include applicable stipend amount requested for the intial period of support and the number of months, actual tuition fees, and the standard institutional allowance* | PI/RA | | 11/13/2023 | |
| Budget Justification | *Justify each line item* | PI/RA | | 11/13/2023 | |
| **OTHER ADMINISTRATIVE DOCUMENTS** | | | | | |
| Cover Letter | *Individual fellowship applicants must include a cover letter that contains a list of referees (including name, departmental affiliation, and institution).* | PI | | 11/17/2023 | done |
| **Introduction** | ***Required - application must include an Introduction addressing issues raised in the previous critique (Summary Statement). Limit: 1 pg*** | PI | | 11/17/2023 | done |
| Project Summary/Abstract | *In addition to summarizing the research project to be conducted under the fellowship award, describe the fellowship training plan and the environment in which the research training will take place. The Limit: 30 lines of text* | PI | | 11/17/2023 | done |
| Project Narrative | *Limit: 2-3 Sentences, lay language* | PI | | 11/17/2023 | done |
| Specific Aims | *Limit: 1 pg* | PI | | 11/17/2023 | done |
| Facilities & Other Resources | *Description of institutional facilities and resources available to the fellowship applicant* | PI/RA | | 11/17/2023 | done |
| Equipment | | PI | Not applicable | 11/17/2023 | na |
| Sponsor Co-Sponsor Statements | *6 page limit.* | PI/RA | | 11/17/2023 | done |
| Letters of Support | *Attachments may be provided (if applicable) by collaborators, consultants, advisors, etc. 6 page limit* | PI/RA | | 11/17/2023 | na |
| **HUMAN SUBJECTS:** | **for human subjects research only - see human subjects form** | | | | |
| Protection of Human Subjects | | PI | | 11/17/2023 | done |
| Data and Safety Monitoring Plan | | PI | | 11/17/2023 | done |
| Inclusion of Individuals across the Lifespan | | PI | | 11/17/2023 | done |
| Inclusion of Women and Minorities | | PI | | 11/17/2023 | done |
| Recruitment and Retention Plan | | PI | | 11/17/2023 | done |
| Study Timeline | | PI | | 11/17/2023 | done |
| Section 4 of HS Form | *Only required if clinical trial* | PI | | 11/17/2023 | done |
| Inclusion Enrollment Report | | PI | | 11/17/2023 | done |
| Respective Contributions | 1 page | PI | | 11/20/2023 | done |
| Selection of Sponsor and Institution | 1 page | PI | | 11/20/2023 | done |
| Responsible Conduct of Research | 1 page | PI | | 11/20/2023 | done |
| Alt Phone Number/Degree Sought/Field of Training | Please review '**PHS Fellowship Supplemental Form**' for details | PI | | 11/20/2023 | |
| Background & Goals of Fellowship and Training | 6 page limit. Consists of a) Doctoral Dissertation and Research Experience; b) Training Goals and Objectives; and c) Activities Planned Under this Award | PI | | 11/20/2023 | done |
| Institutional Environment & Commitment to Training | 2 pages | PI | | 11/20/2023 | done |
| **APPLICATION (Science portion)** | | | | | |
| Research Strategy | Limit: 6 pgs Should address the significance of the proposed studies, including the background leading to the present application; and the approach to provide experiemental support of the proposed hypothesis. | PI | | 11/29/2023 | done |
| References Bibliography | Bibliography of all referenced cited | PI | | 11/29/2023 | done |
| Appendix - Required Materials | Maximum of 10 PDF attachments allowed.Do not use the Appendix to circumvent page limits | PI | | 11/29/2023 | na |
| Fellow/Mentor review of proposal PDFs | Fellow and mentor team to review full proposal PDFs to ensure everything looks accurate and as expected prior to SR's submission | | | 11/29/2023-11/30/2023 | |
| Internal review of full application | SR to review and send notes; RA and PI to resolve any errors so NU approval can be obtained. SR will then submit to grants.gov and PI will receive a confirmation with the grant number. PI to check grants.gov after submission to confirm everything looks as expected. | | | 12/1/2023-12/8/2023 | |

# eRA Commons

- Website used by HHS for submission of NIH, AHRQ grants
- Account must be created by grants manager at university (your RA)
- All communication and updates are through eRA Commons portal
- Your RA will be the one to actually submit, the account is mostly for communications from the funding agency



# Status: PI Search

## Recent/Pending eSubmissions

- Applications that require action (e.g., to view errors/warnings) prior to submission completion
- Applications that are available to view (during two business day correction window) prior to submission completion
- Applications that have been rejected by Signing Official

## List of Applications/Awards

- Funded Awards
- Successfully submitted applications, both paper and electronic
- Review assignment status, review results, summary statements, and Notices of Award
- Other Commons features (e.g., Just In Time, eSNAP, Closeout, Financial Status Report) for previously submitted applications/awards

## Search by Grants.gov Tracking Num

Enter the Grants.gov Tracking Number into the following box for easy access to a specific award application

*Tracking Number* Search



## Contacts

**Administration:** Scientific Review Officer (SRO)
**Name:** Kenney, Nicholas J.
**Phone:** 301-427-1869
**Email:** Nicholas.Kenney@ahrq.hhs.gov

**Administration:** Grants Management Specialist (GMS)
**Name:** Caponiti, Anna
**Phone:** (301) 427-1402
**Email:** anna.caponiti@ahrq.hhs.gov

**Administration:** Program Official (PO)
**Name:** Chanlongbutra, Amornrat
**Phone:** 301-427-1542

# Status Information

*Filter* Expand All Collapse All Print

## 1F32HS029776-01A1

**Status**
Fellowship awarded.

**Project Title**
Long Term Outcomes and Cost-Implications of Inequitable Access to AcuteInpatient Rehabilitation

**PI Name**
Rao, Saieesh

**NIH Appl. ID**
10996951

**Application ID**
1F32HS029776-01A1

## Status

**Status**
Fellowship awarded.

**Last Status Update Date**
06/27/2024

**PI Name**
Rao, Saieesh

**Institution Name**
NORTHWESTERN UNIVERSITY AT CHICAGO

**NIH Appl. ID**
10996951

**School Name**
FEINBERG SCHOOL OF MEDICINE

**School Category**
SCHOOLS OF MEDICINE

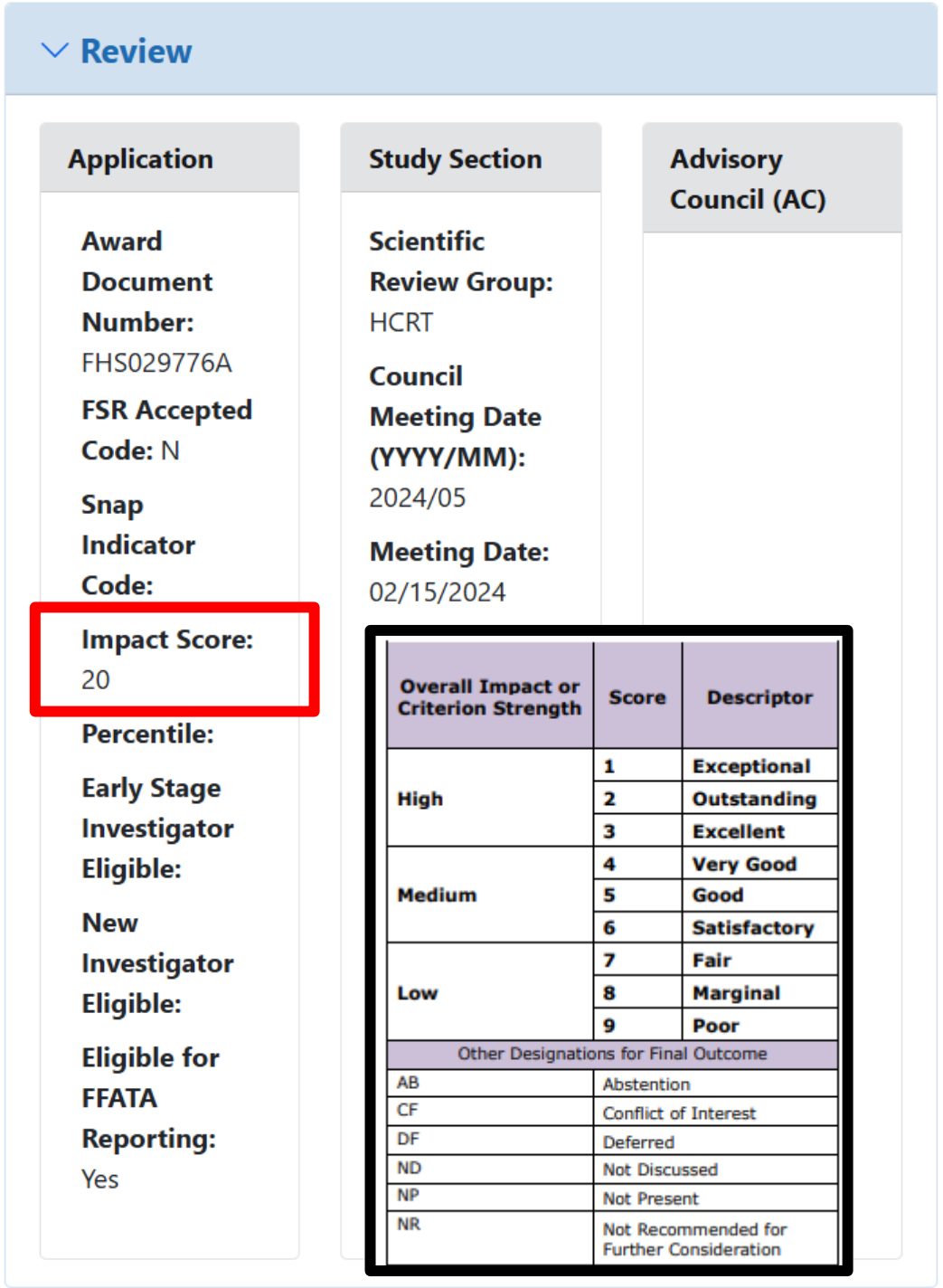
**Division Name**
NONE

**Department Name**

# Priority Score

Found in eRA Commons shortly after the study section meeting date

- The score your application receives is the "priority score" or "impact score"
- Range from 10-90, lower scores are better
- About half of applications are not scored at all after initial review ("ND" – not discussed)
- Initial submission was not funded with a score of 40
- Resubmission was funded with a score of 20
- Percentile based on score was not calculated for my application, but that is an equivalent metric



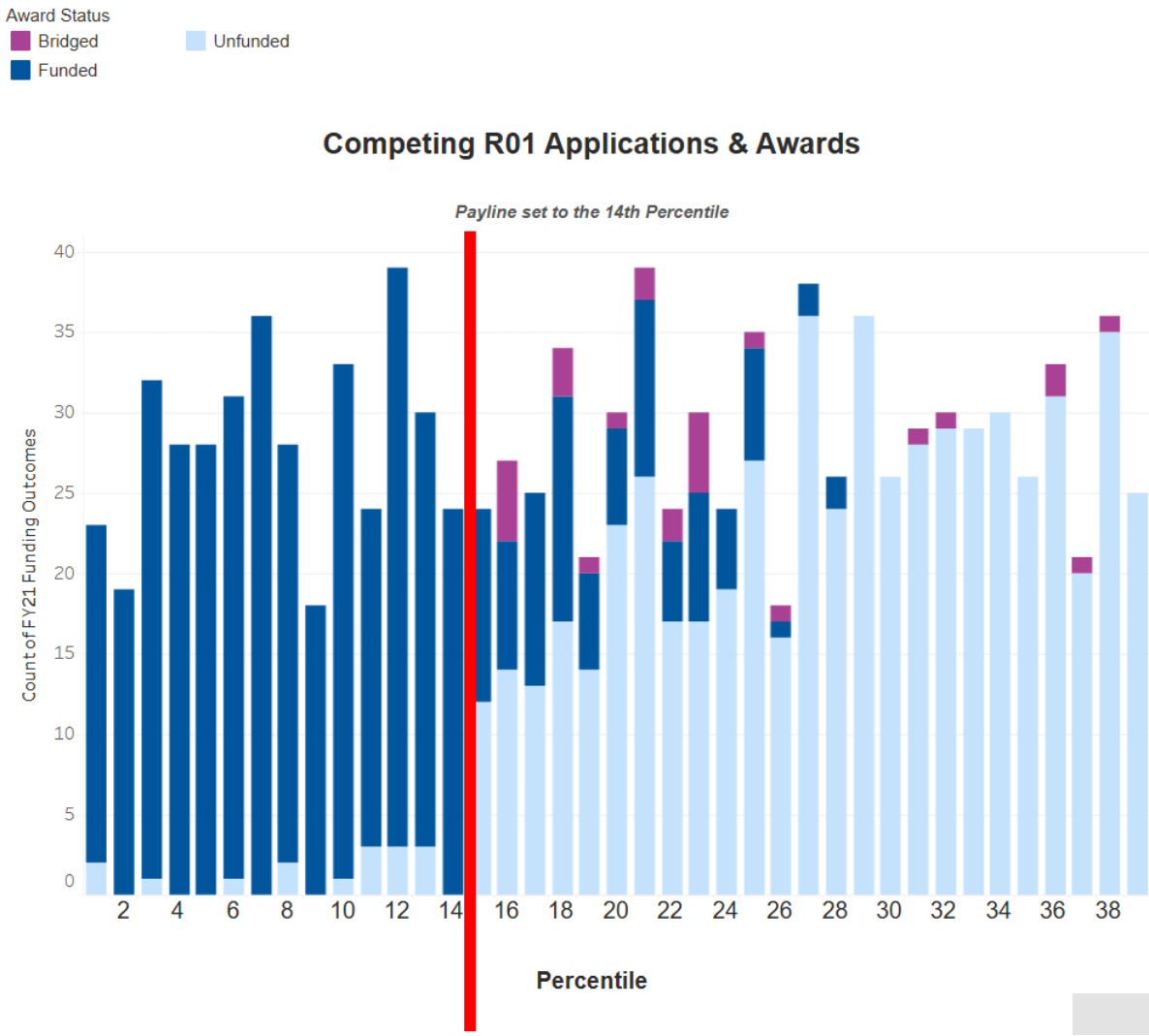
**Review**

| Application | Study Section | Advisory Council (AC) |
|---|---|---|
| **Award Document Number:** FHS029776A<br>**FSR Accepted Code:** N<br>**Snap Indicator Code:**<br>**Impact Score:** 20<br>**Percentile:**<br>**Early Stage Investigator Eligible:**<br>**New Investigator Eligible:**<br>**Eligible for FFATA Reporting:** Yes | **Scientific Review Group:** HCRT<br>**Council Meeting Date (YYYY/MM):** 2024/05<br>**Meeting Date:** 02/15/2024 | |

| Overall Impact or Criterion Strength | Score | Descriptor |
|---|---|---|
| High | 1 | Exceptional |
| | 2 | Outstanding |
| | 3 | Excellent |
| Medium | 4 | Very Good |
| | 5 | Good |
| | 6 | Satisfactory |
| Low | 7 | Fair |
| | 8 | Marginal |
| | 9 | Poor |
| Other Designations for Final Outcome | | |
| AB | Abstention | |
| CF | Conflict of Interest | |
| DF | Deferred | |
| ND | Not Discussed | |
| NP | Not Present | |
| NR | Not Recommended for Further Consideration | |

# Paylines

- Your priority score or percentile is used to compare your application to others
- The payline is the **conservative estimate** of the percentile / score below which your grant will be funded
- Varies cycle to cycle
- Not a sure thing (see graph)



# Benefits of applying

- Even if you don't secure funding:
  - You will have a clear outline of your research strategy
  - You will have identified pitfalls and know what to troubleshoot (data access, IRB approval, institutional red tape)
  - You will be ready to start research years running
  - You will have better rapport with your mentor
  - You will have firsthand experience writing grants, so your first won't be as an attending
  - You can still report your priority score on your CV even if you miss the payline

# Look & Feel of F32 Specific Aims, Research Strategy

Original and Revised Submissions

**Specific Aims**

Spinal cord injury (SCI) is a widespread and debilitating condition affecting an estimated 294,000 patients in the United States.[1] Sequelae range from impaired sensorimotor function to complete paralysis. SCI also has detrimental effects on employment, social reintegration, and healthcare system utilization.[2] Importantly, neurologic losses are mitigated by a post-acute care strategy which emphasizes intensive physical therapy, frequent nursing care, and regular physician visits.[3,4] These activities typically take place at an acute inpatient rehabilitation facility (IRF). IRF care benefits SCI patients who have 0.6 times decreased odds of mortality, 9.4 times increased odds of independent living at one year, and improved neurologic outcomes compared to those not admitted to an IRF.[3] It is thereby imperative that SCI patients are triaged to IRFs for post-acute care.

Despite the benefits of IRF care for SCI patients, our group has shown that publicly insured SCI patients are less likely to receive care at IRFs compared to privately insured patients, even after controlling for age, injury severity, and comorbidities.[5] The reasons for this finding are unclear, as are its long term clinical and fiscal implications. Given that IRF care improves neurologic outcomes, increased access to IRF treatment may improve reduce total long-term healthcare system costs. However, there is a critical literature gap assessing whether such an investment would be cost-effective. Understanding the long-term healthcare costs for patients admitted versus not admitted to an IRF can determine whether upfront investment in IRF care reduces long-term healthcare system costs while improving outcomes and care quality metrics for these patients.

Our overarching goal is to inform healthcare policy at state and national levels by forecasting the clinical and economic implications of expanded care access. Here, our objective is to determine the cost-effectiveness of expanded IRF access in reducing morbidity and healthcare utilization in the SCI patient population. We hypothesize expanded IRF access for publicly-insured SCI patients will reduce long-term morbidity and healthcare resource utilization at readily acceptable cost-effectiveness thresholds. We are prepared to undertake the proposed research because we have extensive experience in clinical care, health economics, economic forecasting, and data analytics using publicly available administrative datasets. We will ensure our findings are relevant and informative to policy makers. We have the following specific aims:

**Aim #1**: **Understand long-term harm associated with SCI patients who received IRF care versus those who did not.** We will use the California Department of Health Care Access and Information (HCAI) dataset to identify SCI patients between 2015-2018 and examine the incidence of SCI-associated complications as enumerated in the AHRQ Quality Indicators and obtained via ICD-10 medical coding data.

> H1: Rates of SCI-associated complications, such as DVTs, pressure ulcers, UTIs, etc. will be higher among patients who undergo rehabilitation at an IRF than those who do not at one year after their index injury after controlling for clinical risk factors such as age, Elixhauser comorbidity index, and New Injury Severity Score.

**Aim #2: Quantify long-term rates of hospital resource use among SCI patients who received IRF care versus those who did not.** We will use the California Department of Health Care Access and Information (HCAI) dataset to identify SCI patients between 2015-2018. We will examine individual patient costs over one year following initial injury, as well as individual costs associated with IRF versus non-IRF care.

> H2: Total healthcare resource utilization, including ED visits, rehospitalization, etc. will be higher among patients who undergo rehabilitation at an IRF than those who do not at one year after their index injury after controlling for clinical risk factors such as age, Elixhauser comorbidity index, and New Injury Severity Score.

**Aim #3: Forecast cost-savings associated with redirecting patients to appropriate post-acute care rehabilitation.** This may involve escalation or de-escalation of care. We will apply care costs from patients cared for at IRFs to matched patients who did not receive IRF care based on aforementioned risk factors.

> H3: Upfront investment in IRF care for SCI patients would reduce long term global cost to the healthcare system at one year, primarily by improving functional outcomes in the post-acute care period and reducing the incidence of SCI-associated complications.

## SPECIFIC AIMS

Traumatic spinal cord injury (**SCI**) is a widespread and debilitating condition affecting an estimated 294,000 patients in the United States.[1] SCI is sudden, unanticipated, and afflicts young to middle aged people in the prime of their lives. Sequelae range from impaired sensorimotor function to complete paralysis. SCI also has detrimental impact on employment, social reintegration, and healthcare system utilization.[2] Importantly, neurologic losses are mitigated by a post-acute care strategy which emphasizes intensive physical therapy, frequent nursing care, and regular physician visits.[3,4] These activities take place at an acute inpatient rehabilitation facility (**IRF**). SCI patients sent to IRF following initial injury have 0.6 times decreased odds of mortality, and 9.4 times increased odds of independent living at one year versus those not sent to an IRF.[3]

Despite the benefits of IRF care for SCI patients, our group has shown that publicly insured SCI patients are less likely to receive care at IRFs compared to privately insured patients, even after controlling for age, injury severity, and comorbidities.[5] The long-term clinical and cost implications are unknown. Given that IRF care improves neurologic outcomes, increased access to IRF treatment may reduce total long-term SCI complications thus reducing healthcare costs. However, there is a critical literature gap assessing whether this investment would be cost-effective long-term. Quantifying the long-term implications for patients admitted versus not admitted to an IRF can determine whether upfront investment in IRF care reduces complications while reducing long-term healthcare costs for injured patients.

**Our overarching goal is to inform healthcare policy at state and national levels by forecasting the clinical and economic implications of expanded care access.** The objective of this application is to determine if expanded IRF access reduces complications and cost among SCI patients. We hypothesize expanded IRF access for publicly-insured SCI patients will reduce long-term complications at acceptable cost-effectiveness thresholds. We have extensive experience in clinical care, health economics, economic forecasting, and data analytics using all-payer claims datasets. We will ensure our findings are relevant and informative to policy makers. We have the following specific aims:

**Aim 1**: **Understand long-term complications and unplanned healthcare use associated with SCI patients who did not receive IRF post-acute care versus those who did.** We will use California Department of Health Care Access and Information (**HCAI**) data to identify traumatic SCI patients aged 18-64 between 2015-2018. We will examine the incidence of SCI-associated complications as indicated by Agency for Healthcare Research & Quality (**AHRQ**) Prevention Quality Indicators. We will compare complications and unplanned healthcare use among patients sent to IRFs, skilled nursing facilities (SNF), and home using multivariable mixed-effects logistic regression models.

*H1: SCI-associated complication rates (e.g., venous thromboembolism, urinary tract infection) will be lower in patients treated at an IRF than those who were not, one year after index injury controlling for patient variables (e.g., age, Elixhauser Comorbidity Index, injury intent, Spine Abbreviated Injury Score).*

**Aim 2: Quantify long-term healthcare costs associated with SCI patients who received IRF care versus those who did not.** We will use the California Department of Health HCAI data to identify traumatic SCI patients aged 18-65 between 2015-2018. We will examine individual patient emergency department, inpatient, and post-acute care costs over one year after initial injury. We will compare costs associated with IRF versus sub-acute nursing facility care using a hierarchical log-transformed linear regression.

*H2: Healthcare cost, including emergency department, inpatient, and post-acute care costs, will be lower in patients treated at an IRF than those who are not at one year after index injury controlling for patient variables.*

**Aim 3: Forecast cost-savings associated with expanded access for SCI patients to IRF for post-acute care rehabilitation.** We will derive and validate a machine learning model for predicting SCI patients' discharge disposition using New York State Emergency Department and Inpatient Discharge Databases from AHRQ's Healthcare Cost and Utilization Project (**HCUP**) 2015-2018. We will apply this model to California patients, predicting their counterfactual rate of IRF utilization, and combine several methods including propensity matching, proportional hazards, and Monte Carlo simulation to calculate subsequent cost-savings.

*H3: Upfront investment in access to IRF care for SCI patients reduces long term healthcare cost at one year.*

## Research Strategy

### 1. Significance

This year in the United States, approximately 17,900 patients will suffer from new spinal cord injury (SCIs).[1] These injuries often occur in the setting of trauma and are initially diagnosed and treated in the acute inpatient setting. While the acute care in the initial hospitalization following injury is critical to preservation of neurologic capabilities, ultimate mitigation of neurologic deficits and maximal recovery depends on the quality of rehabilitation provided in the post-acute care setting. In fact, access to quality rehabilitation, under the guidance of experts trained in the rehabilitation of SCI patients, is one of the most important factors in reducing patient mortality and improving subsequent functional status.[3,4]

Expert rehabilitation tailored to the care of SCI patients is provided at sites known as inpatient rehabilitation facilities (IRFs). Patients are discharged from hospitals to IRFs to complete their course of rehabilitation after their acute hospital needs are met. IRFs provide a space in which patients undergo at least three hours of daily physical therapy and are frequently visited by physicians trained in neurology and rehabilitation.[6] IRF care is associated with 0.6 decreased odds of 1-year mortality and 9.4 greater odds of returning home to live independently.[3] Additionally, patients rehabilitated at IRFs have improved long-term functional outcomes such as increased physical mobility and self-care function compared to those discharged to skilled nursing facilities (SNFs).[4] Given the well described benefits of IRF care for the near-term benefits and functional recovery among SCI patients, it is no surprise that some jurisdictions enforce the provision of IRF care for SCI patients. Regulations in New York state demand that SCI patients be triaged to facilities which can provide IRF-level care; this results in appropriate transfers of SCI patients to higher levels of care for completion of rehabilitation treatment.[7]

Most other states have no such regulations. This allows for the possibility of SCI patients forgoing necessary rehabilitation care and incurring preventable morbidity such as pressure ulcers, urosepsis, deep venous thrombosis (DVT), and otherwise not returning to their highest potential level of function. Previous work by our group examining patients in California, a state without as stringent regulations regarding SCI care as New York, demonstrates that thousands of patients who experience traumatic neurologic injuries, including SCI but also including traumatic brain injury (TBI), are not triaged to IRF level care in the post-acute period. From the available clinical registry data, it is extremely unclear why these patients are not triaged to IRF care. Despite controlling for clinical factors such as patient age, comorbidities, and severity of injury, the most predictive factor distinguishing patients not admitted to IRF care was public insurance status.[5] Identification of this factor suggests that a health policy intervention at state or federal levels may mitigate the disparity in IRF access for publicly insured patients.

Such an intervention would be justified by data documenting reduction of long-term SCI-associated morbidity by IRF care at acceptable cost-effectiveness thresholds. However, there is little data documenting reduction of long-term harms and healthcare costs following IRF care. Our group, having already laid the preliminary groundwork by studying short-term costs associated with IRF care, is expertly poised to assess the long-term healthcare system costs and clinical outcomes associated with access to acute inpatient rehabilitation for SCI patients.

### 2. Innovation

Over the past several years, the team led by Dr. Stey has led research efforts to improve the cost and quality of healthcare in the United States. This work recognizes that drivers of healthcare costs include not only decisions made regarding care in the acute care hospital setting that most physicians are familiar with, but also decisions regarding care in the post-acute care setting as well. There is increasing evidence in the literature that much preventable patient harm and increased healthcare system cost occurs due to inadequate care in the post-acute care setting. For example, understanding that patients undergoing curative cancer surgery remain at increased risk for venous thromboembolism (VTE) after surgery, including post-discharge, informed interventions to reduce this risk.[8–10] We propose to extend the analogy to rehabilitation of SCI patients, arguing that the quality of post-acute care rehabilitation not only influences clinical metrics such as mortality and functional status, as previously described, but also influences long-term healthcare system utilization and

## RESEARCH STRATEGY

### A. SIGNIFICANCE

**A.1. Spinal cord injuries (SCI) are a common and sudden cause of disability in young, working aged people where the degree of disability can be mitigated through access to highly specialized healthcare immediately after injury.** This year in the United States, approximately 17,900 patients will suffer a new SCI.[1] These injuries occur from falls, vehicle collisions, sports accidents, and self-inflicted or interpersonal violence.[1,6] SCI patients are initially treated in specialized hospitals known as trauma centers which provide early definitive care such as neurosurgical decompression[7,8] and mean arterial pressure elevation following injury to promote neurologic healing.[8–11] However, functional recovery depends on rehabilitation in the first year after injury.[3,6,11]

**A.2. Expert rehabilitation tailored to the care of SCI patients occurs at inpatient rehabilitation facilities (IRFs) which improve functional recovery while reducing long-term complications and mortality**. Patients are sent for rehabilitation after initial hospitalization (**Figure 1**). Timely rehabilitation is critical because neurologic adaptation is highest one year after injury.[6] Patients at IRFs do at least three hours of daily physical therapy and are cared by multidisciplinary teams with physicians trained in neurology and rehabilitation.[12] IRF care is associated with 40% decreased odds of mortality and nine-fold greater odds of independent living at one year compared to skilled nursing facility care (**SNF**s).[3,4]

**Figure 1: Independence after SCI can be regained with rehabilitation at IRF**

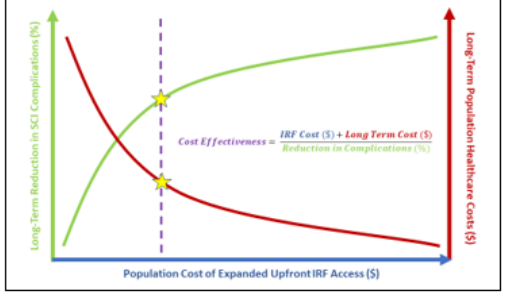

**A.3. Preventable complications occur when SCI patients forgo expert rehabilitation at IRFs.** Examples include urinary tract infections from indwelling catheters preventable with bladder training protocols;[5,13–18] ventilator-associated pneumonias preventable with SCI-specific ventilator weaning protocols;[19–27] and pressure ulcers[28–31] and venous thromboembolism[32–38] from immobility. These complications particularly occur when patients are discharged to SNF.[3] SNFs provide only one hour of rehabilitation daily and lack SCI protocols or multidisciplinary teams. SNFs offer heterogenous care and precipitate functional decline among the disabled.[39]

**A.4. IRF beds are extremely limited which has led to biased patient selection for IRF.** IRF access is limited by insurance coverage,[40,41] race,[42–46] social support,[47] and proximity.[46] Previous work by our group demonstrated that thousands of neurotrauma patients in California are never sent to IRF after hospitalization. That study was motivated by our team's clinical experience working in California that even young, healthy SCI patients were referred to SNF rather than IRF because of anticipated issues with insurance approval. Our study confirmed an inverse association between public insurance and with odds of IRF care despite controlling for age, comorbidities, and injury severity when compared to private insurance.[5]

**A.5. SCI is different from other indications for acute IRF because SCI occurs in young, working aged people who decades of life and potential economic productivity ahead of them.** This imposes large long-term costs to public payers. Despite being only 14.8% of the population, disabled people account for 72% of Medicaid costs and 54% of Medicare costs, having higher per-capita expenditures than the non-disabled.[48–50] Furthermore, SCI patients are often primary earners for families and have potentially decades of economic productivity if neurologic function is regained.[48,51–53]

**A.6. Some jurisdictions have health policies which mandate provision of IRF care for SCI patients.** New York state law requires that hospitals discharge SCI patients to IRFs for high quality rehabilitation.[39] However, most states lack regulations. Patients not sent to IRFs go to SNFs where intensive rehabilitative care is not possible.[3,5] Our team quantified that in California it would take $364 million annually to expand IRF access to all neurotrauma patients.[5] While large, this cost must be viewed in the context of 1) reducing SCI complication rates, 2) reducing emergency and inpatient encounters, and 3) expected resulting cost savings.

**Figure 2: Calculate the ideal investment in IRF access to maximally reduce SCI complications for the least total cost**




**A.7. There is a critical literature gap in whether the upfront cost of IRF care is offset by long-term**

**Specific Aim 1:** Understand long-term harm associated with SCI patients who received IRF care versus those who did not. We will use the California Department of Health Care Access and Information (HCAI) dataset to identify SCI patients between 2015-2018 and examine the incidence of SCI-associated complications as enumerated in the AHRQ Quality Indicators and obtained via ICD-10 medical coding data.

**Rationale for Aim 1:**

Previous literature and our own clinical experience demonstrate that SCI patients experience severe complications requiring hospitalization or emergency treatment as a result of their disability. Incidence of these complications, such as pressure ulcers, urosepsis, and DVT, are critical healthcare quality measures assessed by AHRQ. To establish whether expanded access to IRF care is economically merited for SCI patients, one must establish baseline empirical rates of these complications in both the IRF and non-IRF treated populations.

**Experimental Approach**

To assess the efficacy of IRF care in promoting health and functioning among SCI patients, we will examine AHRQ Prevention Quality Indicators (PQI) Composite Measures in the SCI population for one-year following their acute injury. PQI Composite Measures include rates of inpatient admission for diabetes complications, hypertension, heart failure, community acquired pneumonia, urinary tract infections, and Asthma/COPD as well as rates of lower extremity amputation.[12] We will also track rates of SCI-associated complications not specifically enumerated in the AHRQ PQI Composite Measures, such as incidence of DVTs and urinary retention. Given that a minority of patients will likely experience recurrent complications whereas others may experience none, rates will be determined by calculating the both the number of unique patients who experience complications (so that each patient is only counted once) as well as the total incidence of complications (in which each patient may count more than once).

The HCAI dataset documents every inpatient admission and emergency department encounter in the state of California. To limit our analysis to SCI patients, we will filter for those patients whose records contain an International Statistical Classification of Diseases and Related Health Problems, version 10 (ICD-10) code corresponding to SCI. These codes are S14, S24, and S34, corresponding to injuries of the cervical, thoracic, and lumbosacral spina cord, respectively. Given that ICD-10 codes may be persistent well after the period of a patient's initial injury (to document a history of SCI), index presentations of SCI will be identified by the presence of a corresponding E-code, and ICD-10 code documenting external traumatic circumstances responsible for the patient's presentation. Patient records will be linked across inpatient and ED encounters to identify the index presentation of a patient's spinal cord injury. The time period under examination will be between 2015 and 2018; this period was chosen for ease of analysis given a full conversion from ICD-9 to ICD-10 coding conventions by this time. During record linkage, each patient with an identified index admission associated with traumatic SCI (as indicated by an E-code) will have their initial post-acute care disposition recorded (IRF versus SNF, for example) for follow-up analysis.

Preliminary analysis demonstrates that 22,946 emergency room records in the 2015-2018 study period document a patient encounter with an active or historical diagnosis of SCI. Similarly, 22,328 inpatient encounters involving an active or historical diagnosis are found during the same time period. Once records are linked for individual SCI patients across inpatient and emergency room encounters, we will use several multinomial mixed-effects logistic regression models to evaluate the association between patient demographics (insurance status, race, ethnicity, median household income, and post-acute care disposition after index hospitalization) and morbidity as defined by readmission, emergency room encounters, the incidence of the AHRQ PQI Composite Measures, and incidence of SCI-associated complications as enumerated earlier.

Completion of this aim will result in knowledge of baseline incidences of unexpected healthcare utilization and long-term SCI-associated morbidity. Demographic and clinical factors which indicate increased long-term SCI associated morbidity will be identified as well.

**C.2. Aim 1: Understand long-term complications and unplanned healthcare use associated with SCI patients who did not receive IRF post-acute care versus those who did.** We will use the California Department of Health Care Access and Information (**HCAI**) data to identify traumatic SCI patients aged 18-64 between 2015-2018. We will examine the incidence of SCI-associated complications as indicated by Agency for Healthcare Research & Quality (**AHRQ**) Prevention Quality Indicators. We will compare complications and unplanned healthcare use among patients sent to IRFs vs. sub-acute nursing facilities using multivariable mixed-effects logistic regression models.

C.2.a. **Rationale for Aim 1:** SCI patients experience frequent unplanned encounters with the healthcare system due to complications of their injury. Incidence of these complications, such as pressure ulcers, urosepsis, and DVTs are healthcare quality metrics. This aim will describe baseline incidence of unexpected healthcare use and complications and help establish whether expanded IRF access may reduce complications.

C.2.b. **Preliminary Data:** 22,946 emergency room records not resulting in inpatient admission in the 2015-2018 period document a patient encounter with an active or historical diagnosis of SCI. Similarly, 22,328 inpatient encounters involving an active or historical diagnosis are found during the same period. Given an anticipated complications rate of 25%,[35,61] this gives us 80% power to detect a 5.1% change in complications.[62]

C.2.c. **Data Sources:**

*C.2.c.1.* California Department of Health Care Access and Information (**HCAI**) Patient Discharge Data and Emergency Department Data for years 2015-2018

*C.2.c.2.* Center for Medicare & Medicaid Services (**CMS**) Inpatient Rehabilitation Facility Quality Reporting Program - Provider Data for years 2015-2018

*C.2.c.3.* Center for Medicare & Medicaid Services (**CMS**) Skilled Nursing Facility Quality Reporting Program - Provider Data for years 2015-2018

C.2.d. **Inclusion/Exclusion Criteria:** Patients between the ages of 18 and 64 who present to a California hospital with a new diagnosis of spinal cord injury indicated by International Classification of Disease (**ICD**)-10 diagnosis codes of S14, S24, or S34 will be included. Restricting patient age to non-senior adults reduces the likelihood of poor pre-injury functional status and re-admissions from non-SCI related causes. Patients discharged from acute care hospitalization to long-term care facility and 'other facilities' will be excluded (<20% of discharges) because limited claims data preclude determination of drivers of discharge to these settings. The study period (2015-2018) was chosen given full conversion from ICD-9 to ICD-10 codes by this time.

C.2.e. **Primary Predictor of Interest:** Post-acute care facility following hospitalization for SCI using the 'disp' variable. This will be confirmed with patient record linkage numbers where discharge date of hospitalization is equal to admission date of post-acute care. Additional covariates that will be controlled include age, sex, race, median income of zip code, Elixhauser Comorbidity Score,[63] Abbreviated Injury Severity Score for Spinal Injury, New Injury Severity Score,[64] insurance status and distance from hospital to nearest IRF and SNF.[65] The "icdpicr" package[66] will be used to calculate injury severity scores[67], and the "comorbidity" package[68] will be used to calculate Elixhauser comorbidity scores.[69]

C.2.f. **Outcome Measures:**

*C.2.f.1.* Rates of SCI complications such as pressure ulcers, urosepsis, and deep venous thrombosis at one year following injury as measured by AHRQ Prevention Quality Indicators.[57]

*C.2.f.2.* Rates of emergency department and inpatient encounters at one year following injury.

*C.2.f.3.* Rates of emergency department and inpatient encounters with diagnoses enumerated in the AHRQ prevention quality indicators at one year following injury.

*C.2.f.4.* **Statistical Analysis:** Each patient will have their initial post-acute care facility recorded (IRF, SNF, home). All subsequent encounters for each patient (grouped by patient record linkage number) within one year of initial injury will be tabulated. Complication rates will be determined using both the number of unique patients with complications and the total incidence of complications. Multivariable mixed-effects logistic and Poisson regression models will evaluate the association between patient post-acute care (IRF, SNF, home) and future complications, ED encounters, readmission, and AHRQ Prevention Quality Indicators. Model predictors are in C.2.e. ***k*-fold cross validation** will ensure model reliability.[77,78] All analyses will be in R.

C.2.g. **Potential Problems and Alternative Approaches:** First, despite rigorous exclusion criteria and covariates to control for injury severity and comorbidity, unmeasured variable bias may still be present. Instrumental variable analysis will be used to address this bias;[70] distance between acute care hospital and nearest IRF will be used as the instrumental variable to draw causal inference between IRF post-acute care and SCI-associated preventable complications rates. Second, selection bias may be present in post-acute care facility selection. Inverse probability treatment weighting (IPTW) will control for selection bias in post-acute care. These weights will create a pseudopopulation with confounders equally distributed and included in a second logistic regression modeling SCI-associated complication rates associated with IRF, SNF, and home.

C.2.h. **Timeline:** We expect to use four months (by Nov '23) while also data cleaning and in coursework.

IRF = Inpatient Rehabilitation Facility, SNF = Skilled Nursing Facility. NISS = New Injury Severity Score

0.976] 0.951]

**Specific Aim 2:** Quantify long-term rates of hospital resource use among SCI patients who received IRF care versus those who did not. We will use the California Department of Health Care Access and Information (HCAI) dataset to identify SCI patients between 2015-2018. We will examine individual patient costs over one year following initial injury, as well as individual costs associated with IRF versus non-IRF care.

**Rationale for Aim 2:**

The second arm to establishing the cost-effectiveness of IRFs, after tabulating incidence of SCI-associated morbidity, is to tabulate health-care system costs incurred by SCI-patients over the long term. Our group has previously demonstrated that short-term costs for SCI patients associated with IRF care substantial and unlikely to be offset by short term reductions in morbidity. However, reduced healthcare utilization over a longer time horizon as a result of IRF care may make IRF care appear more cost-effective. While both Aims 1 and 2 are necessary for a cost-effectiveness calculation, they are functionally independent and may be completed separately from each other.

**Experimental Approach**

The experimental approach in Aim 2 largely mirrors that of Aim 1 in terms of the data set used, data filtering performed, and linkage of patient records. For our estimation of healthcare system costs, the HCAI dataset contains charges placed during individual emergency department encounters and inpatient admissions. However, charges placed by healthcare entities are rarely equivalent to the healthcare system costs, as healthcare entities routinely overbill for services and are rarely paid the full amount of their charges.

To estimate healthcare system costs for SCI-related healthcare encounters, we will utilize cost-to charge ratios (CCRs) to convert charge data present in HCAI to healthcare system costs. CCRs are a fundamental tool in econometrics and AHRQ research methodology; charges are converted to costs simply by multiplying the charge by the CCR.[13] Calculation of CCRs involves examination of individual hospital and facility balance sheets; namely, each hospital's CCR is calculated by subtracting the hospital's total operating revenue from total operating expenses, and dividing that difference by the hospital's gross patient's revenue.[14] Fortunately, this information is made available at a granular level by HCAI. Our preliminary work has calculated a CCR for all hospitals in California, with a median CCR of 0.27. This means that for every dollar charged to the California healthcare system, the median healthcare system cost is $0.27. Charges for each encounter at each facility will be converted to costs using each hospital's unique CCR.

Given the prospective nature of possible policy interventions stemming from this work, all healthcare costs will be adjusted for inflation to U.S. dollar amounts in the year that the work is to be published. To do this, we will follow standard econometric procedures adjusting for inflation using the Market Basket Wage index as previously done in our prior work.[5]

**C.3. Aim 2: Quantify long-term healthcare costs associated with SCI patients who received IRF care versus those who did not.** We will use the California Department of Health HCAI data to identify traumatic SCI patients aged 18-64 between 2015-2018. We will examine patients' emergency department, inpatient, and post-acute care costs up to one year after initial injury. We will compare costs associated with IRF versus sub-acute nursing facility care using a hierarchical log-transformed linear regression.

C.3.a. **Rationale for Aim 2:** Our group previously showed that short-term costs for SCI patients associated with IRF care are higher than SNF. However, reduced healthcare utilization after IRF may make IRF care more cost-effective (**Figure 2**). While both Aims 1 and 2 are necessary for a cost-effectiveness calculation, they are functionally independent and may be completed separately from each other.

C.3.b. **Preliminary Data:** Using HCAI data for years 2015-2018, median total cost of acute and post-acute care was $129,000 (Q1-Q3,$72,500-$217,000) for patients sent to IRFs compared to $53,100 (Q1-Q3, $27,900-$154,000) for patients sent to SNFs. Total median adjusted cost difference was $18,461 (95%CI [$5,908– $38,064]) more for patients discharged to IRF versus SNF. Median adjusted cost-per-day at IRF was $1,045 (95%CI [$752-$2,399]) more than for SNF, suggesting higher intensity care. Given the above, we have 80% power to detect a change of $1458 in total median adjusted cost between SNF and IRF cohorts.[71]

C.3.c. **Data Source:**

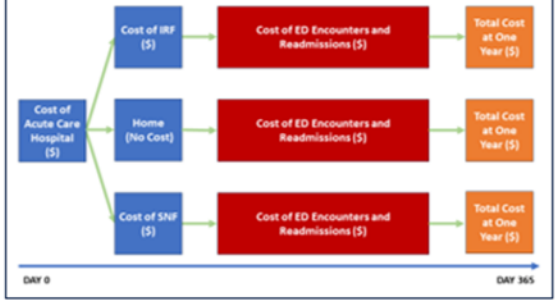
*C.3.c.1.* California Department of Health Care Access and Information (**HCAI**) Patient Discharge Data and Emergency Department Data for years 2015-2018.

*C.3.c.2.* California Department of Health Care Access and Information (**HCAI**) Hospital Annual Financial Disclosure Reports for years 2015-2018.

*C.3.c.3.* Center for Medicare & Medicaid Services (**CMS**) Inpatient Rehabilitation Facility Quality Reporting Program – Provider Data for years 2015-2018.

*C.3.c.4.* Center for Medicare & Medicaid Services (**CMS**) Skilled Nursing Facility Quality Reporting Program – Provider Data for years 2015-2018.

**Figure 3: Contributors to Total Healthcare Cost at One Year**




*C.3.c.5.* Bureau of Economic Analysis Personal Consumption Expenditures (**PCE**) Index for 2015-2018.[72]

C.3.d. **Inclusion/Exclusion Criteria:** See *C.2.d*.

C.3.e. **Primary Predictors:** See *C.2.e*.

C.3.f. **Outcome Measures:**

*C.3.f.1.* Log-cost of initial hospitalization, post-acute care (IRF, SNF, home), and all emergency and inpatient encounters within one year, with subgroup analysis for encounters due to SCI complications.

C.3.g. **Statistical Analysis:** Encounters and charges will be grouped by record linkage number (*C.2.g*).

*C.3.g.1.* Cost to charge conversion: Charges will be derived from emergency department, inpatient, and post-acute care (IRF, SNF, home) encounters (**Figure 3**). To estimate costs from hospital charges, we utilize cost-to charge ratios (**CCRs**). CCRs are a fundamental tool in econometrics and AHRQ methodology. Charges are multiplied by the CCR to yield costs.[73] Calculation of CCRs uses individual hospital and facility balance sheets; namely, each facility's CCR is calculated by subtracting total operating revenue from total operating expenses, and dividing that difference by gross patient's revenue.[74] This information available at a granular through HCAI. Preliminary data shows a median CCR of 0.27 for all hospitals in California; for every dollar charged in California, the median healthcare system cost is $0.27. Charges for each encounter at each facility for each year will be converted to costs using each facility's unique CCR.

*C.3.g.2.* Adjust for inflation: costs will be adjusted for inflation to the year of publication using the PCE Price Index[72] as suggested by AHRQ's Medical Expenditure Panel Survey (MEPS).[75,76]

*C.3.g.3.* Cost modeling: The association of predictor variables with long term healthcare costs will be analyzed using hierarchical multivariable log-transformed linear regression. ***k*-fold cross validation** with starting k=10 as suggested by the literature will be used to ensure performance and reliability of the model.[77,78]

C.3.h. **Potential Problems and Alternative Approaches:** Cost data are highly skewed which may bias cost predictions. We will winsorize extreme outliers of CCR and costs to the 1% and 99% percentile and repeat analyses with and without winsorization. CCR are missing in up to 5% of facilities per year. We will use multiple imputations with the 'mice' package in R[79] to predict missing CCRs based on facility characteristics.

C.3.i. **Timeline:** We expect four months to complete this aim (Nov '23 – Feb '24) while also in coursework.

# Look & Feel of F32 Background & Goals of Fellowship Training

Revised Submission

## CANDIDATE'S BACKGROUND

### A. Doctoral Dissertation & Research Experience

2011-2012

Title: **Association of Mast Cells with Colon Cancer Progress**
Role: Student Researcher, Northwestern University
PI: Khashayarsha Khazaie, PhD DSc, Department of Immunolog Chicago, IL (now at Mayo Clinic, AZ)

Project Summary: My first exposure to research was in the lab a examined mast cell density in human colonic tissue and its corre from normal tissue (euplasia) to dysplastic and neoplastic tissue well as immunohistochemistry to identify mast cells in tissue. Ma using ImageJ. I found that increased mast cell density was signi histology, suggesting mast cell-driven inflammation as a possibl

Skills Developed: I was introduced to laboratory research and pr skills in data collection, wet lab protocols, and statistics. I preser form at the Illinois Math & Science Academy's IMSAloquium Res

2014-2017

Title: **Investigating Structure-Function Relationships in Cata**
Role: Student Researcher, University of Chicago
PI: Joseph Piccirilli, PhD

Project Summary: Ribonucleic acids (RNA) are responsible for c gene transfer. Capable of both catalysis and heredity, RNA is int expanded known RNA biochemistry by analyzing the catalytic ac Using both experiment and computation, our group discovered a cation in the RNA's active site and published in the prestigious

Skills Developed: Building on wet lab methods from the Khazaie synthesis, HPLC, gel electrophoresis, and kinetic studies with ra my intellectual independence, owning my experiments and pres

2015

Title: **Investigating the Oncogenic Potential of Mutations in**
Role: Student Researcher, Memorial Sloan Kettering Cancer Ce
PI: Omar Abdel-Wahab, MD, Human Oncology and Pathogenes Kettering Cancer Center, New York City, NY

Project Summary: The Abdel-Wahab lab at MSKCC uses functic epigenetic drivers of leukemias and lymphomas. Having studied Lab, I was intrigued by Dr. Abdel-Wahab's lab investigation of sy translation of the *XPO1* gene. These errors altered XPO1's activ p53 from the nucleus. By engineering leukemic cell lines with m *XPO1* knockdown with shRNAs inhibits cell proliferation, sugges

Skills Developed: My time in the Abdel-Wahab lab was the caps applied the biochemistry of RNA translation to the clinical questi drove tumorigenesis. In addition to gaining familiarity with viral t microscopy, I also assisted with mouse models and scaling proj

2017-2019

Title: **Development of a Machine Learning Model for Rapid D**
Role: Medical Student Researcher, University of Chicago Pritzke
PI: Matthew Churpek, MD MPH PhD, University of Chicago Pritz IL (now at University of Wisconsin – Madison)

Project Summary: Delays in care timeliness lead to morbidity, m costs for acutely ill patients. While several early warning scores patients, these scores do not point to the reversible causes of cl deficiency, we developed a machine learning model to accurate among high-risk inpatients. Models were trained on over one th

clinical deterioration. Results demonstrated 91% sensitivity in de detecting sepsis, and over 70% in detecting volume overload, hy arrhythmia based on vital sign trends alone. I presented at the 2 (ATS) International Conference, and it was the basis for Dr. Chu

Skills Developed: This was a departure from my prior wet-lab re Stata, and Python, and gained familiarity with machine learning forest models. These skills have been continuously useful in my

## CAREER GOALS AND OBJECTIVES

### B. Goals for Fellowship and Training

My **long-term** goal is to be an independently funded investigator focusec quality of surgical care by *planning* and *predicting* the long-term effects of policy state, and national levels. To this end, I hope to exploit the large-scale increase i to predict these outcomes with big data and simulation methodologies. My prima rigorous simulation of *counterfactual data* (that is, data which does not yet exist interventions) from existing datasets using state-of-the-art machine learning and career development award will fill gaps in my knowledge of health policy and ski machine learning that limit my ability to effectively answer outstanding questions

The **short-term** objectives of this F32 proposal are to address training g an early career independent investigator. Since policy interventions typically can implementation using conventional randomized controlled trial approaches, meti experiments are used to qualitatively predict the effects of interventions in an un propose to extend this methodology by using natural experiments in one popula treatment effects in a second population of interest. Doing this requires me to ac **aims**: quantitative methods in **(1)** Healthcare Quality to understand the current d Healthcare System and quality measurement structures; **(2)** Health Economics t inferences **(3)** Machine Learning to use non-parametric approaches to answer h Scientific Writing and Dissemination of Research to ensure sustained research c This proposal is an experiential application of training in the above four learning aims map one-to-one with my specific aims. I have selected my sponsors and c program, and research environment with attention to their ability to help me achi

## CAREER DEVELOPMENT PLAN AND TRAINING ACT

### C. Activities Planned under Award

This proposal involves gaining new knowledge and skills to examine the rehabilitation on the long-term clinical and fiscal outcomes of spinal cord injury ( **research aims** are to **(1)** Determine the effect of access to post-acute care on t complications and healthcare encounters in a large, longitudinal; **(2)** Determine t disposition on the healthcare costs of SCI patients in that same patient registry; and econometrics to predict the effect of an intervention increasing access to inp patients' long-term clinical and fiscal outcomes. As a resident in general surgery and regularly sees SCI-associated complications, I have highly relevant clinical study. I additionally have prior experience with machine learning, supercomputin However, I have no formal training, and I have identified four learning aims to ac improving health systems and policy. I have identified **coursework in the four l** quality, health economics, machine learning, and scientific writing and dissemina During the first year of training, I will complete an in-person **Master's in Health Research** (HSOR) at Northwestern University addressing three of the four learn **Machine Learning coursework** over two years, providing formal training in all l **three research aims is expected to take 75% FTE, whereas coursework is e travel, conferences, and mentorship meetings are expected to take the rem**

**TABLE 1: CAREER DEVELOPMENT TIMELINE AND MENTORSHIP**

| Components of Career Development Plan |
|---|
| **Healthcare Quality** |
| Federal Policy Making and Healthcare Reform (HSR 470) Northwestern University |
| Ethical Issues in Health Services Research (HSR 460) Northwestern University |
| Mentorship with Tara Lagu, MD MPH PharmD and Anne Stey, MD MSc |
| **Health Economics (Learning Aim 2)** |
| Health Economics & Healthcare Financing (HSR 433) Northwestern University |
| Topics in Health Services Research: Methods and Measurement (HSR 433) Northwestern Univers |
| Applied Quantitative Methods & Analysis for Researchers (HSR 456) Northwestern University |
| Main and Advanced Causal Inference Workshop (August 2024) Northwestern University |
| Mentorship with Alexander Lundberg, PhD |
| Mentorship with Adin-Cristian Andrei, PhD |
| **Machine Learning (Learning Aim 3)** |
| *Statistical Horizons* Machine Learning for Estimating Causal Effects 3-Day Remote Seminar |
| *Statistical Horizons* Longitudinal Data Analysis Using R 3-Day Remote Seminar |

**TABLE 2: Primary and Co-Mentors, Scientist, Scientific Advisors, and Statistics Advisor**

| Scientist | Role | Mentoring Contribution | Meetings |
|---|---|---|---|
| **Anne Stey, MD MSc** (*Assistant Professor of Surgery – Trauma Surgery*) | Primary Sponsor | • Provide research expertise in design and experimental methods for relating to econometrics and data analysis<br>• Mentorship for a career in health policy and economics as a surgeon-scientist<br>• General oversight of career development and research deliverables | • Weekly virtual or in-person check-in<br>• Weekly research group meetings |
| **Allen Heinemann, PhD** (*Professor of Physical Medicine and Rehabilitation, Emergency Medicine, and Medical Social Sciences*) | Co-Sponsor | • Director of the Center for Rehabilitation Outcomes Research at Shirley Ryan Ability Lab, the #1 rehabilitation hospital in U.S.<br>• Provide expertise in the practical care of spinal cord injury patients and metrics for evaluating the success of rehabilitation<br>• Advisor for scientific writing regarding rehabilitation outcomes and preparation for conference presentations | • Monthly meeting concurrent with weekly research group meeting<br>• Ad-hoc meetings |
| **Tara Lagu, MD MPH** (*Director, Institute for Public Health and Medicine – Center for Health Services & Outcomes Research; Professor of Medicine and Medical Social Sciences*) | Co-Sponsor | • Co-investigator with Dr. Stey and Dr. Heinemann on project<br>• Mentorship in Health Services and Public Health research<br>• Provide expertise in disability care based on past work on that subject | • Monthly meeting concurrent with weekly research group meeting<br>• Ad-hoc meetings |
| **Alexander Lundberg, PhD** (*Assistant Professor of Emergency Medicine*) | Co-Sponsor | • Member of the Buehler Center for Health Policy and Economics<br>• Provide additional research expertise in health economics, econometrics, and health law | • Weekly research group meetings |
| **Adin-Cristian Andrei, PhD** (*Professor of Preventative Medicine and Biostatistics*) | Co-Sponsor | • Expertise in machine learning, computationally intensive methods, propensity score methods for causal inference, and survival analysis<br>• Mentorship in statistical design and choice of computational methods | • Bimonthly meeting concurrent with weekly research group meeting<br>• Ad-hoc meetings |

**LEARNING AIMS**

**1. Healthcare Quality**

**1.1. Mentorship (Anne Stey, MD, MSc, Tara Lagu, MD, MPH, PharmD):** Dr. Lagu is a Professor of Medicine at Northwestern University and a renowned health policy researcher. She studies health disparities among marginalized groups, particularly those with disabilities, and has practical experience outside the academy, including two years at the Centers for Medicare and Medicaid Services developing hospital quality metrics. She has mentored over 30 trainees and a dozen junior faculty in obtaining career development awards.

**1.2. Structured Meetings:** I will attend monthly research group meetings with Dr. Lagu as well as ad-hoc remote meetings as necessary. They will support Research Aim 1 and throughout.

**1.3. Coursework:** I will complete Federal Policy Making and Healthcare Reform (HSR 470) and Ethical Issues in Health Services Research (HSR 460) for the Master's.

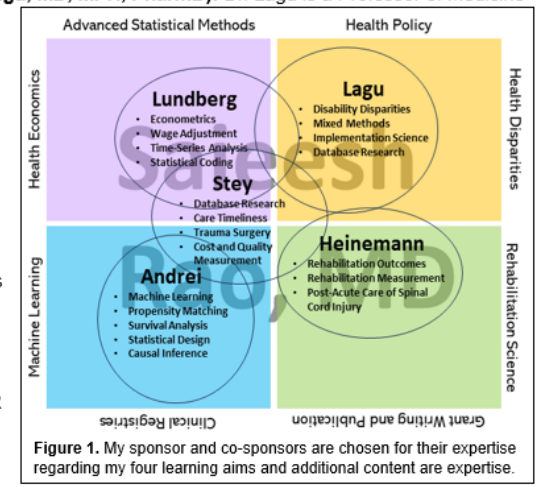


**Figure 1.** My sponsor and co-sponsors are chosen for their expertise regarding my four learning aims and additional content are expertise.

**2. Health Economics**

**2.1. Mentorship (Alexander Lundberg, PhD):** Research Aims 2 and 3 provide the opportunity for formal training in health economics. Dr. Lundberg is an Assistant Professor and applied microeconomist at Northwestern University. He has taught econometrics and computer programming at both the graduate and undergraduate levels, and he received the 2021 Teaching Excellence Award at Northwestern University for his graduate course in biostatistics with Stata. He also has direct experience coding in many of the domains for this project (e.g., cost-to-charge ratios in administrative datasets, comorbidity and injury severity indexes, Monte Carlo simulations, medical diagnosis codes, wage index adjustments).

**2.2. Structured Meetings:** I will attend weekly research group meetings with Dr. Lundberg as well as ad-hoc remote meetings as necessary. He will support Research Aims 2 and 3 and throughout.

# Look & Feel of AAS and ACS Applications

# AAS Application

1 cover page
5 research strategy
1 applicant biosketch
1 mentor biosketch
2 LOR
1 budget
1 lay summary of project

~11 pages you are responsible for

These pages you see are the entire application (minus LOR and biosketch)

Top 10 invited for 15-minute zoom interview in mid December

Interview is low-stress, just be eloquent about your project and able to respond to 1) predictable critiques of the study design and 2) your expected career trajectory

Dear Members of the Review Committee:

Following two-years of clinical training in surgery, I have gained thousands of hours experiencing healthcare system challenges faced by patients and providers. I look forward to studying these issues though research, coursework, and mentorship over a two-year protected period, for which I am applying for AAS/AASF funding. My proposal is to study the impact of post-acute care disposition on the long-term outcomes and healthcare system costs for patients with traumatic spinal cord injuries. The time developing myself as a researcher and leader will be the catalyst for an influential academic career, shaping healthcare policy for surgical patients.

Prior to surgical residency at Northwestern, I completed my undergraduate and medical school training at the University of Chicago, where I received the Frances E. Knock Prize in Biological Chemistry for being the highest performing undergraduate in the major and subsequently received a majority-tuition merit scholarship to the medical school. My long-term goal is to become an NIH-funded academic surgeon studying issues in healthcare policy and economics, with particular focus on surgical patients. My inspiration derives from both the mentorship of those who have succeeded in this sphere as well as personal experience with gaps in healthcare coverage during my childhood and its associated stresses.

My short-term goals for the fellowship period are intentional and numerous. My broad vision is to gain skills in grant writing, scientific presentation, computational methods, and economic theory. I have selected my mentor, co-mentors, and research environment with attention to their ability to help me achieve these goals. My specific goals include:

1. Research Skills:
   a. Formulate fundamental research questions in healthcare economics and policy
   b. Develop and execute research plans utilizing sound statistical methodology
   c. Improve my understanding of the American Healthcare System through directed coursework (funded outside of AAS/AASF fellowship)
   d. Contribute to work in cost-effectiveness analysis and understand the process by which research results may be used to shape real-world healthcare policy
2. Funding and Scientific Writing:
   a. Author grant applications independently with feedback from mentors
   b. Publish abstracts, manuscripts, and book chapters pertinent to my research area
   c. Review journal articles in the healthcare policy and economics sphere to improve my reviewing skills and familiarity with current work in the field
   d. Disseminate research findings through poster and oral presentations at national conferences, such as the Academic Surgical Congress
3. Professional Development and Leadership:
   a. Network with leaders in healthcare economics and policy at national conferences
   b. Grow through leadership positions at institutional, local, and national levels
   c. Mentor younger trainees, both clinically and in research related to this work

I am grateful to the Review Committee for their time and thoughtful consideration of my application for the AAS/AASF Trainee Research Fellowship Award.

Sincerely,
Saieesh Rao
General Surgery, PGY-3
Northwestern University

**Lay Summary of Project (295 words)**

Spinal cord injury (SCI) affects an estimated 294,000 patients in the United States and often occurs in the setting of trauma. Sequelae of SCI range from impaired sensorimotor function to complete paralysis, leading to detrimental effects on employment, social integration, and healthcare system utilization. Importantly, neurologic losses are mitigated by a post-acute care strategy which emphasizes rehabilitative care provided at acute inpatient rehabilitation facilities (IRFs). Despite the benefits of IRF care for SCI patients, not all patients with spinal cord injuries are treated at IRFs. Recent work from our group has shown that publicly insured SCI patients are less likely to receive care at IRFs compared to privately insured patients, even after controlling for age, injury severity, and comorbidities. The reasons for this finding are unclear. It is unknown to what degree lack of IRF care for SCI patients increases their long-term morbidity and healthcare utilization, and it is unknown whether cost-savings from decreased long-term healthcare utilization would justify expanded access to IRF care. In **Aim 1**, we will characterize rates of harm associated with SCI, such as pressure ulcers, urosepsis, and deep venous thrombosis, among patients who received IRF care versus those who did not. In **Aim 2**, we will quantify rates of unplanned healthcare resource use, measured in dollar costs of rehospitalization and emergency department encounters, among SCI patients who received IRF care versus those who did not. In **Aim 3**, we will forecast healthcare system costs associated with triaging patients to appropriate post-acute care rehabilitation and calculate the cost-effectiveness of such a move. The knowledge gained from this project will increase our understanding of the role of post-acute care on healthcare system costs, generally, and directly inform healthcare policy interventions regarding the post-acute care of trauma patients with spinal cord injury, specifically.

**Title: Long term outcomes and cost-implications of inequitable access to acute inpatient rehabilitation**
**PI: Saieesh Rao**
**Northwestern University**

**Budget Justification**

**Total requested funding support:**

| | |
|---|---|
| Salary Support: | $27,000 |
| Travel Support: | $3,000 |
| Personnel: | $0 |
| Data Acquisition: | $0 |
| Coursework: | $0 |
| Equipment: | $0 |
| Total: | **$30,000** |

**Funded Persons**

**Saieesh Rao, Principal Investigator (full time effort x 2 years)**
Dr. Rao holds ultimate responsibility for completion of research aims described in the project proposal and all aspects of the training program. He will be involved full-time during the proposed two-year research period, free from mandatory clinical duties otherwise associated with his surgical training; the AAS/AASF fellowship will provide partial salary and travel support during the first year only. He will be responsible for data integrity, analysis, and dissemination of discovered results. At the time of funding, Dr. Rao will have completed three-years of post-graduate clinical training in surgery, and his stipend for the following two post-graduate years per the NIH pay scale is as follows:

**Trainee Stipend Year 1 (2024-2025): $59,592 (Level 3)**
**Trainee Stipend Year 2 (2025-2026): $61,572 (Level 4)**

The Department of Surgery at Northwestern University aims to provide Dr. Rao the above salaries via a mix of intramural departmental funds, research funds, and extramural funds such as those provided by the AAS/AASF fellowship. As all data, equipment, and personnel are already available for the project independent of Dr. Rao's funding mechanism, the AAS/AASF research fellowship will primarily serve to support Dr. Rao's salary and conference travel during the one year funding period (2024-2025).

**Abstract For Research Proposal**

Spinal cord injury (SCI) affects an estimated 294,000 patients in the United States, usually after trauma.[1] Functional impairments after SCI are mitigated by rehabilitative care provided at inpatient rehabilitation facilities (IRFs).[2,3] Despite the benefits of IRF care for SCI patients, minority and un/under-insured patients with SCI are less likely to receive care at IRFs.[4] The long-term implications on SCI patients' health and healthcare utilization from limited access to IRF care has never been documented. As a result, it is unclear whether cost-savings from decreased healthcare utilization would justify policies to expand IRF access for SCI patients.[5,6]

In **Aim 1**, we will characterize rates of long-term harm associated with SCI, such as pressure ulcers, urosepsis, and deep venous thrombosis, among patients who received IRF care versus those who did not. In **Aim 2,** we will quantify long-term healthcare use, measured in dollar costs of unplanned care (emergency department encounters and rehospitalization), among SCI patients who received IRF care versus those who did not. In **Aim 3,** we will forecast healthcare system costs at one-year post-injury associated with expanded IRF access and calculate the cost-effectiveness of such a move. The knowledge gained from this project will directly inform policy interventions regarding the post-acute care of SCI patients.

**Significance of Research**

This year in the United States, approximately 17,900 patients will suffer from new spinal cord injury (SCIs).[1] While care provided during the initial hospitalization is critical to neurologic recovery, mitigation of neurologic deficits and maximal recovery depends on the quality of rehabilitation provided in the post-acute care setting. In fact, access to quality rehabilitation, under the guidance of experts trained in the rehabilitation of SCI patients, is one of the most important factors in reducing patient mortality and improving subsequent functional status.[2,3,8]

Expert rehabilitation tailored to SCI patients is provided at inpatient rehabilitation facilities (IRFs). There, patients undergo intensive physical therapy and are frequently visited by physicians trained in neurology and rehabilitation.[16] Receipt of IRF care is associated with 0.6 decreased odds of 1-year mortality and 9.4 greater odds of returning home to live independently.[2] Additionally, patients rehabilitated at IRFs have improved functional outcomes compared to those discharged to skilled nursing facilities (SNFs).[3,8,9] Given the benefits of IRF care for SCI patients, some jurisdictions enforce IRF care for SCI patients; regulations in New York mandate that SCI patients be triaged to facilities which can provide IRF-level care.[11]

Most other states have no such regulations. Without regulations, SCI patients often forgo necessary rehabilitation and incur preventable morbidity such as pressure ulcers, urosepsis, and deep venous thrombosis (DVT).[3,8] Previous work by our group examining patients in California demonstrates that thousands of SCI patients are not triaged to IRF level care. Despite controlling for factors such as patient age, comorbidities, and severity of injury, the most predictive factor distinguishing patients not admitted to IRF care is public insurance status.[4] This finding suggests that a health policy intervention at a state or federal level may mitigate the disparity in IRF access for publicly insured patients.

**Background Information**

Over the past several years, Dr. Stey and her team have led research efforts to improve the cost and quality of healthcare in the United States. This work recognizes that healthcare costs are driven by decisions made in both the acute care hospital setting as well as the post-acute care setting.[7] Given that post-acute care rehabilitation improves mortality rates and functional status, it is likely that rehabilitation also reduces long-term harm, healthcare system utilization and therefore costs.[8,9] Demonstrating a net reduction in long-term healthcare system costs from adequate rehabilitation care may renew policy efforts to expand IRF access for SCI patients.

A study of long-term harm and healthcare system costs associated with SCI has never been undertaken. This is in part due to the challenge of tracking long-term costs and outcomes for individual patients across multiple years.[5,6] Our group has access to the unique data from the California Department of Health Care Access and Information (HCAI) to tackle this challenge.[9] HCAI datasets track individual patient encounters with the healthcare system in California across multiple years using a unique patient identifier. HCAI data also documents costs associated with these encounters, including for acute and post-acute care. HCAI provides granular hospital level data as well on both acute and post-acute care hospitals which can be linked to the patient-level datafiles. Our group is already intimately familiar with the HCAI dataset through previous work analyzing short term costs associated with IRF care.[4] The methodology to both track patients' every healthcare encounter over the span of years, as well as forecasting cost-implications at a granular patient level, requires advanced computational capacity not typically employed in health services research. I have significant experience with supercomputing from my prior research training, and I have secured access to Northwestern University's Quest high performance computing cluster in anticipation of undertaking this proposed research.

**Preliminary Observations**

***Healthcare System Costs Associated with IRF Care Greatly Exceed That of Sub-acute Nursing Facility (SNF) Care***

Our group has demonstrated that SCI patients incur significantly greater healthcare system costs during their post-acute care when discharged to IRFs instead of skilled nursing facilities (SNFs). Median total cost of acute and post-acute care was $129,000 (Q1-Q3,$72,500-$217,000) at IRFs compared to $53,100 (Q1-Q3, $27,900-$154,000) at SNFs. The total median adjusted cost difference was $18,461 (95%CI [$5,908– $38,064]) at IRFs compared SNFs. This directly also translated into higher median cost-per-day was $1,045 (95%CI [$752-$2,396]) at IRFs more than at SNFs, suggesting more intensive rehabilitation care.

Applied to the original study sample of 59,193 publicly insured patients over the 2015-2017 period, mandatory IRF care for SCI patients would cost the State of California $1.09 billion, or about $364 million annually. The substantial cost of IRFs compared to SNFs suggests that universal expansion of IRF care would not be cost-effective *without long-term reductions* in SCI-associated long-term harm and healthcare utilization to offset short-term costs.

| Disposition | Private N=11998 (%) | Public N=59193 (%) | Self-pay N=2230 (%) | Other N=2698 (%) | Total N=83230(%) |
|---|---|---|---|---|---|
| Home | 14618 (76.5) | 37375 (63.1) | 1994 (89.4) | 2127 (78.8) | 56114 (67.4) |
| IRF | 2249 (11.8) | 4616 (7.8) | 98 (4.4) | 292 (10.8) | 7255 (8.7) |
| LTAC | 262 (1.4) | 837 (1.4) | 11 (0.5) | 26 (1.0) | 1136 (1.4) |
| SNF | 1979 (10.4) | 16365 (27.6) | 127 (5.7) | 254 (9.4) | 18725 (22.5) |

**Table 1.** Patient Discharge Disposition After Acute Hospitalization by Insurance Status. IRF = Inpatient Rehabilitation Facility, SNF = Skilled Nursing Facility, LTAC = Long Term Acute Care. Other defined as government or indigent programs

***Publicly Insured Patients Are Less Likely to Go to IRFs than the Privately Insured***

We examined whether insurance status alone – (Medicaid/Medicare) versus private – was a significant predictor of patients' discharge destination following acute hospitalization. Medicaid/Medicare insured patients and self-pay patients were less likely to discharge to IRFs after SCI when compared to privately insured patients (**Table 1**). Only 7.8% of Medicaid/Medicare insured patients were discharged to IRFs compared to 11.8% of privately insured patients. Conversely, 27.6% of Medicaid/Medicare insured patients were discharged to SNFs compared to 10.4% of privately insured patients.

Medicaid/Medicare insured patients had 2.17 times greater odds of being discharged to SNFs versus IRFs (95%CI [2.01-2.34], p<0.001) than those who were privately insured (Table 2). Similarly, Medicaid/Medicare insured patients had 35% greater odds of discharge home versus IRF (95%CI [1.27-1.43], p<0.001) and 32% greater odds of discharge to long-term care versus IRF (95%CI [1.13-1.55], p=0.001) compared to the privately insured.

| Patient Characteristics | SNF/IRF OR† [95% CI]* | | Home/IRF OR [95% CI] | | LTAC/IRF OR [95% CI] | |
|---|---|---|---|---|---|---|
| **Insurance Status** | | | | | | |
| Private | Reference | | Reference | | Reference | |
| Public | 2.166 | [2.007-2.338]‖ | 1.346 | [1.266-1.431]‖ | 1.321 | [1.126-1.550]‖ |
| Self-pay | 1.579 | [1.197-2.084]‖ | 3.104 | [2.505-3.847]‖ | 0.887 | [0.466-1.692] |
| Other§ | 1.264 | [1.043-1.530]‖ | 1.145 | [0.993-1.321] | 0.848 | [0.551-1.307] |
| **Age** | 1.036 | [1.035-1.038]‖ | 0.997 | [0.995-0.998]‖ | 0.999 | [0.996-1.003] |
| **Weighted Elixhauser Comorbidity Index** | 1.001 | [0.998-1.004] | 0.957 | [0.954-0.960]‖ | 1.047 | [1.042-1.053]‖ |
| **NISS** | 0.974 | [0.971-0.976]‖ | 0.949 | [0.947-0.951]‖ | 1.010 | [1.006-1.015]‖ |

**Table 2.** Patient Insurance Status Associated with Odds of Discharge to Types of Inpatient Care Facility. IRF = Inpatient Rehabilitation Facility, SNF = Skilled Nursing Facility, LTAC = Long Term Acute Care.

***Medicaid/Medicare-Insured Patients Are Older, Sicker, Poorer, and More Likely be Minorities than the Privately Insured***

Medicaid/Medicare insured patients were older (61.1 vs 42.3 years, respectively), had a lower median household income ($34,388 vs $36,481), had more comorbidities (Weighted Grouped Elixhauser Comorbidity Index >=5; 46.3% vs 23.8%) compared to the privately insured. Additionally, Medicaid/Medicare insured patients were more frequently Black (7.8% vs 5.3%) and Hispanic (28.9% vs 25.5%). Contrary to our expectations, it appeared that patients who may be more likely to need a higher level of care due to age, comorbidities, and possibly socioeconomic status were not afforded the opportunity to undergo rehabilitation at an IRF. Additionally, these patient factors did not differ significantly among patients discharged to IRF, SNF, or Long-term Acute Care (LTAC) (**Table 2**).

**Experimental Plan, With Methods and Materials by Specific Aims**

***Specific Aim 1: Understand long-term harm associated with SCI patients who did not receive IRF care compared to those who did.***
***Hypothesis:*** We hypothesize that healthcare harm at one-year following SCI, will be lower among patients admitted to IRF post-acute care than patients discharged to SNF.
***Data Source:*** We will use the California Department of Health Care Access and Information (HCAI) dataset to identify SCI patients between 2015-2018. HCAI documents every inpatient admission and emergency department (ED) encounter in the state of California. We will link these records to the HCAI Hospital Utilization Reports which provide in-depth characterization of each licensed acute and post-acute care hospital facility in California.
***Inclusion Criteria:*** We will define SCI patients as those whose records contain an International Classification of Disease 10 Clinical Modification codes (ICD-10-CM) code S14, S24, or S34, corresponding to injuries of the cervical, thoracic, and lumbosacral spinal cord, respectively. Initial presentations of SCI will be identified by the presence of a corresponding ICD external cause of morbidity (E-code) documenting external traumatic circumstances responsible for the patient's presentation. Each individual observation will be linked to each individual patient using a unique patient Record Linkage Number. Subsequent post-acute care disposition (IRF versus SNF, for example) following index hospitalization are also captured in HCAI. All analyses will be in R; the icdpicr package[13] will be used to calculate patients' injury severity scores (ISS) from ICD-10 codes during index hospitalization[14], and the comorbidity package[15] will be used to calculate patients' Elixhauser comorbidity scores from ICD-10 codes as well.[16]
***Outcome Measure:*** To assess the efficacy of IRF care in reducing long-term morbidity among SCI patients, we will examine the incidence of post-injury long-term harm. This variable will be a composite of Agency for Healthcare Research and Quality (AHRQ) Prevention Quality Indicator (PQI) and Patient Safety Measures (PSI) Composite Measures. PQI Composite Measures include rates of inpatient admission for diabetes complications, hypertension, heart failure, community acquired pneumonia, urinary tract infections, Asthma/COPD, and lower extremity amputation.[12] We will also track rates of SCI-associated complications enumerated in the AHRQ PSI)Measures, such as incidence of DVTs, in-hospital falls with fracture, pressure ulcers which are known complications of SCI.[2] Rates will be determined by both the number of unique patients who experience complications (so that each patient is only counted once) as well as the total incidence of complications (in which each patient may count more than once).
**Statistical Analysis:** Preliminary analysis demonstrates that 22,946 emergency room records in the 2015-2018 study period document a patient encounter with an active or historical diagnosis of SCI. Similarly, 22,328 inpatient encounters involving an active or historical diagnosis are found during the same time period. Multivariable mixed-effects logistic regression models will evaluate the association between patient post-acute care disposition after index hospitalization while controlling for insurance status, race, ethnicity, median household income, ISS, Elixhauser comorbidity score on subsequent AHRQ PQI and PSI Composite Measures and adjusting for initial acute care hospital variables.

***Specific Aim 2: Quantify long-term costs of hospital resource use among SCI patients who did not receive IRF care compared to those who did.***
***Hypothesis:*** We hypothesize that long-term healthcare costs, measured to one-year following SCI, will be lower among patients admitted to IRF post-acute care than patients discharged to SNF. Cost-savings are expected to be driven by lower rates of rehospitalization and emergency department encounters among SCI patients who are treated at IRFs.
**Data Source:** The HCAI patient level dataset contains hospital charges placed during individual emergency department and inpatient encounters linked to Hospital Utilization Reports.
***Inclusion Criteria:*** Injured patients will be identified as described above in the patient data set.
***Outcome Measure:*** We will examine individual patient costs to the healthcare system for the care of each SCI patients during the year following initial injury. To estimate healthcare costs from hospital charges, we will utilize annual hospital-specific cost-to charge ratios (CCRs), which permit conversion of charges to costs simply by multiplying the charge by the CCR.[17] Calculation of CCRs involves examination of individual hospital and facility balance sheets; namely, each hospital's CCR is calculated by subtracting the hospital's total operating revenue from total operating expenses, and dividing that difference by the hospital's gross patient's revenue.[18] Preliminary work shows that California hospitals have a median CCR of 0.27; conversion of charges to costs in our analysis will uses each hospital's unique CCR. All healthcare costs will be adjusted for inflation to U.S. dollar amounts in the year that the work is to be published. We will also adjust for cost of living using the Market Basket Wage Index.[4]
***Statistical Analysis:*** We will use a multivariable mixed-effects log-transformed linear regression model to evaluate the association between post-acute care discharge disposition on total healthcare cost on year following injury while controlling for patient and hospital variables.

***Specific Aim 3: Forecast cost-savings associated with redirecting patients to IRF care.***
***Hypothesis:*** We hypothesize that long-term healthcare cost-saving for California are expected among SCI patients who are treated at IRFs.
**Data Source:** The HCAI patient level emergency department and inpatient encounters linked to Hospital Utilization Reports.
***Inclusion Criteria:*** Injured patients will be randomly sampled from the patient data set described above.
***Outcome Measure:*** Nationwide healthcare cost one-year post-injury costs.
***Statistical Analysis:*** We will use three methods to estimate the cost-implications of hypothetical health policy proposals for expanding IRF access.

The first estimate simulates mandating IRF care for all patients diagnosed with SCI across the US. Census data and state-level rates of SCI will be applied. Mean long-term cost-differences (savings or increases) from mandated IRF care would be added to the empirical costs of non-IRF care for an upper bound on cost-implications associated with policy change. Similarly, the converse proposal would also be tested, assigning all patients to SNF care, and calculating the resultant cost-difference.

Second, we will estimate savings from a policy which reassigns some but not all patients to IRF care. Using a multivariable mixed-effects logistic regression model, we will classify whether patients should have been admitted to an IRF and apply cost-differences only to those patients who were reclassified. Patients identified to have the most need for IRF care by the model would be prioritized. Insurance status will be excluded as a predictor of post-acute care disposition, so that model results are based only on medical complexity. Sensitivity analysis will be performed by adjusting the model's threshold for reassignment of patients to IRF care.

Third, we will use propensity matching to identify similar patients treated at IRFs and non-IRFs on the basis of demographic and medical factors, and measure pairwise differences in long-term costs and healthcare utilization between them. Given that our preliminary data demonstrates that patients triaged to IRFs are in the minority, regardless of insurance status, we would allow for matching with replacement so as many patients are matched even if IRF patients are counted several times; this is because the point of the matching is to calculate a hypothetical pairwise cost-implication for the effect of IRF care on patients not triaged to an IR. For this method, we would conduct a sensitivity analysis on the "caliper size" in the matching algorithm; namely, how closely two patients must resemble each other to be matched.

**Potential Problems and Pitfalls**

First, 2% of hospitals do not report financial metrics to calculate a CCR. This would prevent calculations of healthcare costs. For those hospitals, we will assume a CCR of 0.27, the median CCR of all other hospitals in the state of California. Second, undocumented patients will be excluded due to lack of a Record Linkage Number to link encounters. Third, the rates and costs associated with the care of SCI-patients obtained from California may not be representative of analogous nationwide. However, we will use national census data, AHRQ reports and RAND data to incorporate state level distributions of injury patterns, payer mix and post-acute care patterns to obtain representative estimates for each state.

# ACS Application

1 cover letter
1 specific aims
3 research strategy
1 applicant biosketch
1 mentor biosketch
2 LOR
1 budget justification

~9 pages you are responsible for

These pages you see are the entire application (minus LOR and biosketch)

Dear Members of the Review Committee,

I am a surgeon scientist passionate about improving the cost and quality of surgical care in the United States. Currently, I am a general surgery resident at the McGaw Medical Center of Northwestern University taking two years of dedicated research time starting in July 2024. Over the last year, I have worked with Drs. Stey, Lagu, Heinemann, and Lundberg to understand the healthcare system cost burden posed by the acute and post-acute care of neurologically injured patients. This proposal builds on a larger body of work by our group analyzing long-term quality and cost implications of poor access to acute and post-acute care in America.

My overarching career goal is to shape state and federal healthcare policy in ways which reduce healthcare system costs while improving the care of surgical patients. My interest stems from personal experiences growing up with gaps in healthcare coverage as well as clinical experiences seeing financial toxicity associated with surgical care. In my career as a university-affiliated academic surgeon, I hope to conduct research in surgical economics, both describing current patterns of healthcare expenditure and predicting the effect of hypothetical health policy changes on these patterns.

I strongly believe that effective advocacy for surgical patients requires surgeons to articulate the specific policy reforms which lawmakers ought to approve. To do this, it is imperative that suggested policy reforms be backed by evidence that they will improve care quality and reduce costs. Given the logistical barriers to conducting real-world trials testing health policy reforms, the next best avenue is to use econometric methods to forecast their fiscal and clinical impact.

Academically, I possess a strong technical background in mathematical modeling, statistics, and computer science gained during my undergraduate and medical school years. However, I have no formal training in health economics or analysis of surgical datasets. The research plan contained herein furthers my career development by pairing my existing skillset with the analysis of surgical patient registries for econometric analysis, under the guidance of mentors formally trained in health economics and health services research. The two-year period will prove foundational to my academic career, and I sincerely hope the ACS shares my optimism that I will mature into a leading voice advocating for surgical patients at the highest levels of academia and government.

Sincerely,

Saieesh Rao

Saieesh Rao, MD
General Surgery PGY-3
Department of Surgery
Feinberg School of Medicine
Northwestern University

**Title: Long term outcomes and cost-implications of inequitable access to acute inpatient rehabilitation**
**Post-doctoral Scholar: Saieesh Rao**
**Northwestern University**

**Budget Justification**

**Total requested funding support:**

| | |
|---|---|
| **Year 1 (2024-2025):** | **$30,000** |
| Salary Support: | $26,000 |
| Travel Support: | $1,000 |
| Publication Fees: | $3,000 |
| Personnel: | $0 |
| Data Acquisition: | $0 |
| Coursework: | $0 |
| Equipment: | $0 |
| **Year 2 (2025-2026):** | **$30,000** |
| Salary Support: | $26,000 |
| Travel Support: | $1,000 |
| Publication Fees: | $3,000 |
| Personnel: | $0 |
| Data Acquisition: | $0 |
| Coursework: | $0 |
| Equipment: | $0 |
| Total: | **$60,000** |

**Key Personnel**

**Saieesh Rao, Post-doctoral Scholar (full time effort x 2 years)**
Dr. Rao holds ultimate responsibility for completion of research aims described in the project proposal and all aspects of the training program. He will be involved full-time during the proposed two-year research period, free from mandatory clinical duties otherwise associated with his surgical training. He will be responsible for data integrity, analysis, and dissemination of discovered results. At the time of funding, Dr. Rao will have completed three-years of post-graduate clinical training in surgery, and his stipend for the following two post-graduate years per the NIH pay scale is as follows:

**Trainee Stipend Year 1 (2024-2025): $59,592 (Level 3)**
**Trainee Stipend Year 2 (2025-2026): $61,572 (Level 4)**

The Department of Surgery at Northwestern University aims to provide Dr. Rao the above salaries via a mix of intramural departmental funds, faculty research funds, and extramural funds such as those provided by the ACS Resident Research Scholarship. As equipment and personnel are already available for the project independent of Dr. Rao's funding mechanism, the ACS Resident Research Scholarship will primarily serve to support Dr. Rao's salary, manuscript publication fees, and mandatory conference travel to the Annual Clinical Congress during the two-year funding period (2024-2026).

**Specific Aims**

Spinal cord injury (SCI) affects an estimated 294,000 patients in the United States and is usually acquired in the setting of trauma.[1] While care provided during the initial hospitalization is necessary for recovery, mitigation of long-term neurologic deficits depends on the quality of post-acute care rehabilitation. It is well attested that quality rehabilitation is crucial for reducing SCI-related morbidity and mortality.[2–4]

Expert rehabilitation tailored to SCI patients is provided at inpatient rehabilitation facilities (IRFs). SCI patients in IRFs have 0.6 decreased odds of 1-year mortality, 9.4 greater odds of returning home to live independently, and improved functional outcomes compared to those discharged to SNFs.[2–6] Given these benefits, some jurisdictions enforce IRF care for SCI patients; regulations in New York mandate that SCI patients be triaged to facilities which can provide IRF-level care.[7]

Most other states have no regulations. Without regulations, SCI patients forgo necessary rehabilitation and incur preventable morbidity such as pressure ulcers, urosepsis, and deep venous thrombosis (DVT).[6,8] Our work examining patients in California demonstrates that thousands of SCI patients are not triaged to IRFs. Despite controlling for patient age, comorbidities, and severity of injury, the most predictive factor identifying patients not admitted to IRF care is receipt of public insurance.[9] Thus, a health policy intervention at a state or federal level may mitigate the disparity in IRF access for publicly insured patients. Given that post-acute care rehabilitation improves SCI-associated outcomes, it is likely that rehabilitation also reduces long-term harm, healthcare system utilization, and costs.[4,6,10] Demonstrating a net reduction in long-term healthcare system costs from adequate rehabilitation may renew policy efforts to expand IRF access for SCI patients.

My overarching goal is to inform healthcare policy at state and national levels by forecasting the clinical and economic implications of expanded care access. Here, my objective is to determine the cost-effectiveness of expanded IRF access in reducing morbidity and healthcare utilization in the SCI patient population. We hypothesize that expanded IRF access for publicly-insured SCI patients will reduce long-term morbidity, healthcare resource utilization, and healthcare system costs. My team is prepared to undertake the proposed research because we have extensive experience in clinical care, health economics, economic forecasting, and data analytics using publicly available administrative datasets. We will ensure our findings are relevant and informative to policy makers. We have the following specific aims:

**Aim #1**: **Understand long-term harm associated with SCI patients who did not receive IRF care versus those who did.** We will use the California Department of Health Care Access and Information (HCAI) dataset to identify SCI patients between 2015-2018 and examine the incidence of SCI-associated complications as enumerated in the AHRQ Quality Indicators and obtained via ICD-10 medical coding data.

H1: Rates of SCI-associated complications, such as DVTs, pressure ulcers, UTIs, etc. will be lower among patients who undergo rehabilitation at an IRF than those who do not at one year after their index injury after controlling for clinical risk factors such as age, Elixhauser comorbidity index, and New Injury Severity Score.

**Aim #2: Quantify long-term rates of hospital resource use among SCI patients who did not receive IRF care versus those who did.** We will use the California Department of Health Care Access and Information (HCAI) dataset to identify SCI patients between 2015-2018. We will examine individual patient costs over one year following initial injury, as well as individual costs associated with IRF versus non-IRF care.

H2: Long-term healthcare costs, measured to one-year following SCI, will be lower among patients admitted to IRF post-acute care than patients discharged to SNF. Cost-savings are expected to be driven by lower rates of rehospitalization and emergency department encounters among SCI patients who are treated at IRFs.

**Aim #3: Forecast cost-savings associated with redirecting patients to appropriate post-acute care rehabilitation.** This may involve escalation or de-escalation of care. We will apply care costs from patients cared for at IRFs to matched patients who did not receive IRF care based on aforementioned risk factors.

H3: Upfront investment in IRF care for SCI patients will reduce long term healthcare system costs at one year while reducing incidence of aforementioned SCI-associated harms, thereby making IRF care for SCI-patients cost-effective at a healthcare system level.

**Research Strategy**

**1. Feasibility Data Supporting Proposed Aims**

***Healthcare System Costs Associated with IRF Care Greatly Exceed That of SNF Care***

Our group has demonstrated that SCI patients incur significantly greater healthcare system costs during their post-acute care when discharged to IRFs instead of skilled nursing facilities (SNFs). Median total cost of acute and post-acute care was $129,000 (Q1-Q3,$72,500-$217,000) at IRFs compared to $53,100 (Q1-Q3, $27,900-$154,000) at SNFs. The total median adjusted cost difference was $18,461 (95%CI [$5,908–$38,064]) at IRFs compared SNFs. Median cost-per-day was $1,045 (95%CI [$752-$2,399]) higher at IRFs than at SNFs, suggesting more intensive rehabilitation care.

Applied to the original study sample of 59,193 publicly insured patients over the 2015-2017 period, mandatory IRF care for SCI patients would cost the State of California $1.09 billion, or about $364 million annually. Thus, universal expansion of IRF care would not be cost-effective *without long-term reductions* in SCI-associated long-term harm and healthcare utilization to offset short-term costs.

***Publicly Insured Patients Are Less Likely to Go to IRFs than the Privately Insured***

We found that Medicaid/Medicare insured patients and self-pay patients were less likely to discharge to IRFs after SCI and more likely to discharge to SNFs when compared to privately insured patients (**Table 1**). Medicaid/Medicare insured patients had 2.17 times greater odds discharge to SNFs versus IRFs (95%CI [2.01-2.34]; p<0.001) than the privately insured. Similarly, Medicaid/Medicare insured patients were more likely to discharge to home or long-term acute care (LTAC) than IRF compared to the privately insured (**Table 2**).

| Disposition | Private N=19108 (%) | Public N=59193 (%) | Self-pay N=2230 (%) | Other N=2699 (%) | Total N=83230(%) |
|---|---|---|---|---|---|
| Home | 14618 (76.5) | 37375 (63.1) | 1994 (89.4) | 2127 (78.8) | 56114 (67.4) |
| IRF | 2249 (11.8) | 4616 (7.8) | 98 (4.4) | 292 (10.8) | 7255 (8.7) |
| LTAC | 262 (1.4) | 837 (1.4) | 11 (0.5) | 26 (1.0) | 1136 (1.4) |
| SNF | 1979 (10.4) | 16365 (27.6) | 127 (5.7) | 254 (9.4) | 18725 (22.5) |

**Table 1.** Patient Discharge Disposition After Acute Hospitalization by Insurance Status. IRF = Inpatient Rehab Facility, SNF = Skilled Nursing Facility, LTAC = Long Term Acute Care. Other payor was defined as government or indigent programs.

***Publicly-Insured Patients Are Older, Sicker, Poorer, and More Likely Minority than the Privately Insured***

Medicaid/Medicare insured patients were older (61.1 vs 42.3 years, respectively), had a lower median household income ($34,388 vs $36,481), and had more comorbidities (Weighted Grouped Elixhauser Comorbidity Index >=5; 46.3% vs 23.8%) compared to the privately insured. Additionally, Medicaid/Medicare insured patients were more frequently Black (7.8% vs 5.3%) and Hispanic (28.9% vs 25.5%). Contrary to our expectations, these publicly insured patients were less likely to be triaged to IRFs despite being at subjectively higher risk of needing higher level care, suggesting a disparity in access on the basis of insurance (**Table 2**).

| Patient Characteristics | SNF/IRF OR* [95% CI] | | Home/IRF OR [95% CI] | | LTAC/IRF OR [95% CI] | |
|---|---|---|---|---|---|---|
| **Insurance Status** | | | | | | |
| Private | Reference | | Reference | | Reference | |
| Public | 2.166 | [2.007-2.338] | 1.346 | [1.266-1.431] | 1.321 | [1.126-1.550] |
| Self-pay | 1.579 | [1.197-2.084] | 3.104 | [2.505-3.847] | 0.887 | [0.466-1.692] |
| Other* | 1.264 | [1.043-1.530] | 1.145 | [0.993-1.321] | 0.848 | [0.551-1.307] |
| **Age** | 1.036 | [1.035-1.038] | 0.997 | [0.995-0.998] | 0.999 | [0.996-1.003] |
| **Weighted Elixhauser Comorbidity Index** | 1.001 | [0.998-1.004] | 0.957 | [0.954-0.960] | 1.047 | [1.042-1.053] |
| **NISS** | 0.974 | [0.971-0.976] | 0.949 | [0.947-0.951] | 1.010 | [1.006-1.015] |

**Table 2.** Patient Insurance Status Associated with Odds of Discharge to Types of Inpatient Care Facility. IRF = Inpatient Rehabilitation Facility, SNF = Skilled Nursing Facility, LTAC = Long Term Acute Care.

**2. Approach**

***Specific Aim 1: Understand long-term harm associated with SCI patients who did not receive IRF care versus to those who did.***

***Hypothesis:*** We hypothesize that healthcare harm at one-year following SCI, will be lower among patients admitted to IRF post-acute care than patients discharged to SNF.

***Data Source:*** We will use the California Department of Health Care Access and Information (HCAI) dataset to identify SCI patients between 2015-2018. HCAI documents every inpatient admission and emergency department (ED) encounter in the state of California. We will link these records to the HCAI Hospital Utilization Reports which provide in-depth characterization of each acute and post-acute care facility in California.

***Inclusion Criteria:*** We will define SCI patients as those whose records contain an International Classification of Disease 10 Clinical Modification codes (ICD-10-CM) code S14, S24, or S34, corresponding to injuries of the cervical, thoracic, and lumbosacral spinal cord, respectively. Initial presentations of SCI will be identified by the presence of a corresponding ICD external cause of morbidity (E-code) documenting external traumatic circumstances responsible for the patient's presentation. Each individual observation will be linked to each individual patient using a unique patient Record Linkage Number. Subsequent post-acute care disposition is also captured in HCAI. All analyses will be in R; the icdpicr package[11] will be used to calculate patients' injury severity scores (ISS) from ICD-10 codes during index hospitalization[12], and the comorbidity package[13] will be used to calculate patients' Elixhauser comorbidity scores from ICD-10 codes as well.[14]

***Outcome Measure:*** To assess the efficacy of IRF care in reducing long-term morbidity among SCI patients, we will examine the incidence of long-term harm post-injury. This variable will be a composite of Agency for Healthcare Research and Quality (AHRQ) Prevention Quality Indicator (PQI) and Patient Safety Measures (PSI) Composite Measures. PQI Composite Measures include rates of inpatient admission for diabetes complications, hypertension, heart failure, community acquired pneumonia, urinary tract infections, Asthma/COPD, and lower extremity amputation.[15] We will also track rates of SCI-associated complications enumerated in the AHRQ PSI Measures, such as incidence of DVTs, in-hospital falls with fracture, and pressure ulcers which are known complications of SCI.[2] Rates will be determined by both the number of unique patients who experience complications (so that each patient is only counted once) as well as the total incidence of complications (in which each patient may count more than once).

**Statistical Analysis:** Preliminary analysis shows 22,946 emergency room records and 22,328 inpatient encounters in the 2015-2018 study period documenting a patient encounter with an active or historical diagnosis of SCI. Multivariable mixed-effects logistic regression models will evaluate the association between aforementioned outcome measures and post-acute care disposition after initial injury while controlling for insurance status, race, ethnicity, median household income, ISS, and Elixhauser comorbidity score.

***Specific Aim 2: Quantify long-term costs of hospital resource use among SCI patients who did not receive IRF care versus to those who did.***

***Hypothesis:*** We hypothesize that long-term healthcare costs, measured to one-year following SCI, will be lower among patients admitted to IRF post-acute care than patients discharged to SNF given expected lower rates of rehospitalization and emergency department encounters among SCI patients who are treated at IRFs.

***Data Source:*** The HCAI patient level dataset contains hospital charges placed during individual emergency department and inpatient encounters linked to Hospital Utilization Reports.

***Inclusion Criteria:*** SCI patients will be identified as described in the inclusion criteria for Specific Aim 1.

***Outcome Measure:*** We will examine individual patient costs to the healthcare system for the care of each SCI patients during the year following initial injury. To estimate healthcare costs from hospital charges, we will utilize annual hospital-specific cost-to charge ratios (CCRs), which permit conversion of charges to costs simply by multiplying the charge by the CCR.[16] Calculation of CCRs involves examination of individual hospital and facility balance sheets; namely, each hospital's CCR is calculated by subtracting the hospital's total operating revenue from total operating expenses, and dividing that difference by the hospital's gross patient's revenue.[17] Preliminary work shows that California hospitals have a median CCR of 0.27; conversion of charges to costs in our analysis will uses each hospital's unique CCR. All healthcare costs will be adjusted for inflation to the year that the work is to be published and to cost-of-living using the Market Basket Wage Index.[9]

***Statistical Analysis:*** We will use a multivariable mixed-effects log-transformed linear regression model to evaluate the association between total healthcare cost one year following injury and post-acute care discharge disposition while controlling for patient and hospital variables as enumerated in Specific Aim 1.

***Specific Aim 3: Forecast cost-savings associated with redirecting patients to appropriate post-acute care rehabilitation.***

***Hypothesis:*** Expansion of IRF access for publicly insured patients will result in healthcare system cost-saving.

***Data Source:*** The HCAI emergency and inpatient encounters linked to Hospital Utilization Reports.

***Inclusion Criteria:*** Injured patients will be randomly sampled from the patient data set described above.

***Outcome Measure:*** Nationwide healthcare cost one-year post-injury.

***Statistical Analysis:*** We will use three methods to estimate the cost-implications of expanding IRF access:

The first estimate simulates mandating IRF care for all patients diagnosed with SCI across the US. Census data and state-level rates of SCI from RAND and AHRQ will be applied. Mean long-term cost-differences (savings or increases) from mandated IRF care would be added to the empirical costs of non-IRF care for an upper bound on cost-implications associated with policy change. Similarly, the converse proposal would also be tested, assigning all patients to SNF care, and calculating the resultant cost-difference.

Second, we will estimate savings from a policy which reassigns some but not all patients to IRF care. Using a multivariable mixed-effects logistic regression model, we will classify whether patients should have been admitted to an IRF and apply cost-differences only to those patients who were reclassified. Patients identified to have the most need for IRF care by the model would be prioritized. Insurance status will be excluded as a predictor of post-acute care disposition, so that model results are based only on medical complexity. Sensitivity analysis will be performed by adjusting the model's threshold for reassignment of patients to IRF care.

Third, we will use propensity matching to identify similar patients treated at IRFs and non-IRFs on the basis of demographic and medical factors, and measure pairwise differences in long-term costs and healthcare utilization between them. Given that our preliminary data demonstrates that patients triaged to IRFs are in the minority, regardless of insurance status, we would allow for matching with replacement so as many patients are matched even if IRF patients are counted several times; this is because the point of the matching is to calculate a hypothetical pairwise cost-implication for the effect of IRF care on patients not triaged to an IR. For this method, we would conduct a sensitivity analysis on the "caliper size" in the matching algorithm; namely, how closely two patients must resemble each other to be matched.

**Potential Problems and Pitfalls**

First, 2% of hospitals do not report financial metrics to calculate a CCR. This would prevent calculations of healthcare costs. For those hospitals, we will assume a CCR of 0.27, the median CCR of all other hospitals in the state of California. Second, undocumented patients will be excluded due to lack of a Record Linkage Number to link encounters. Third, the rates and costs associated with the care of SCI-patients obtained from California may not be representative of analogous nationwide. However, we will use national census data, AHRQ reports and RAND data to incorporate state level distributions of injury patterns, payer mix and post-acute care patterns to obtain representative estimates for each state.

Time permitting within the confines of the scholarship period, we will replicate the above analyses using Medicare claims data. Medicare data contains many of the same variables related to hospital charges, ICD-10 diagnoses, and post-acute care discharge disposition as HCAI but is limited to patients above the age of 65 years old or those already on disability.[18] A subgroup analysis on healthcare system costs and clinical outcomes of publicly-insured SCI-patients in HCAI who meet Medicare eligibility criteria and comparison to findings in he Medicare dataset would lend credence to the nationwide generalizability of our findings in the HCAI dataset if found to be similar to findings in the Medicare dataset.

**Bibliography**

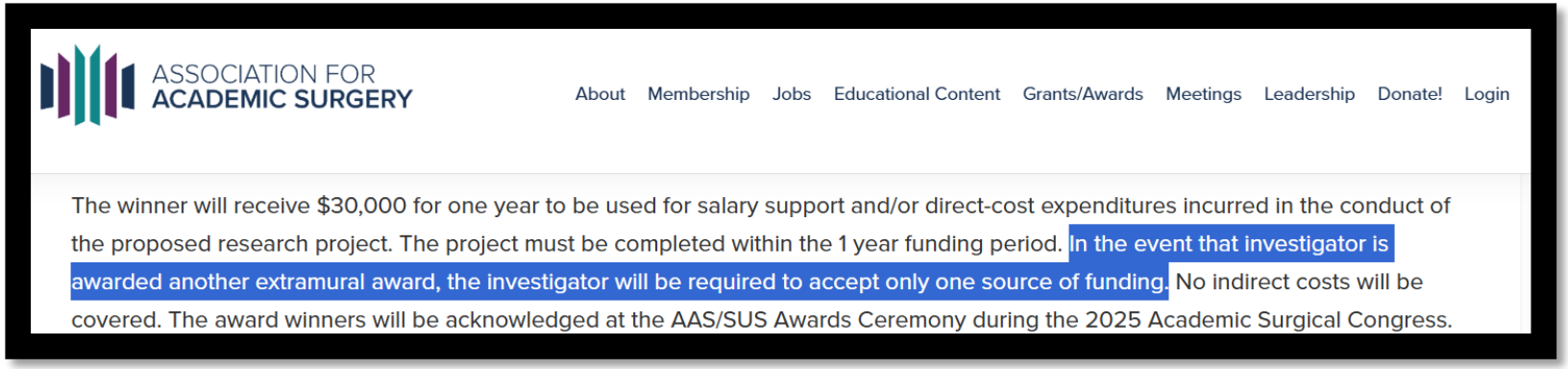
# Edge Cases

Dealing with Multiple Funding Sources

# Awards Unable to be Combined

## Declined AAS Award in favor of ACS

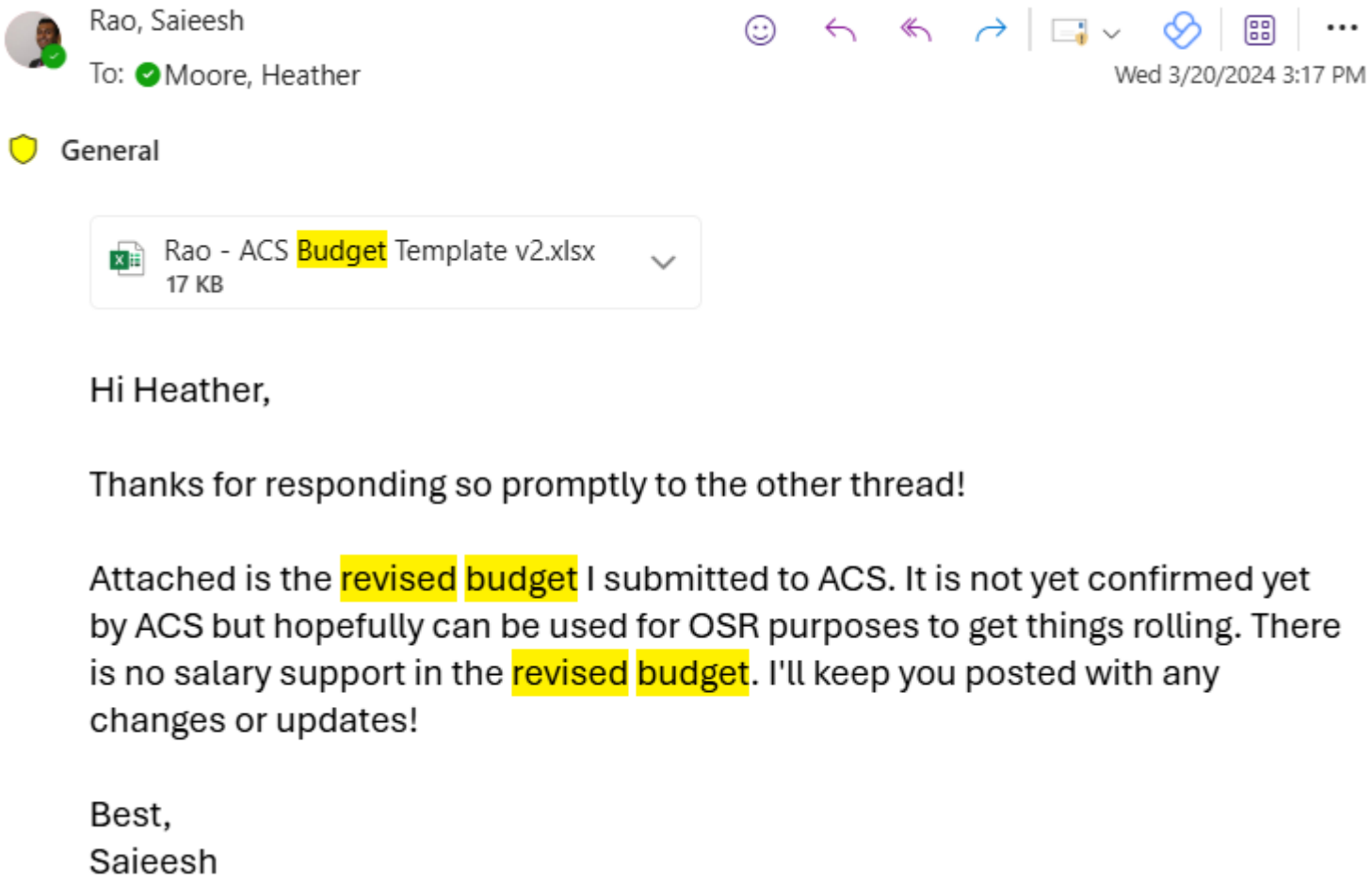
- An application for the ACS Resident Research Scholarship may be submitted even if comparable application to other organizations has been made.
- If the recipient is submitting, submitted, and/or offered a scholarship, fellowship, or research award from another extramural organization, it is the responsibility of the recipient to contact the College's Scholarships Administrator. Those applicants receiving other extramural awards will have to choose between the ACS award and the other awarding body. Intramural awards are allowed (e.g., departmental support, institutional training grant, institutional career development award)
- Applicants who have already earned extramural research funding for their research period, irrespective of funding source or scientific overlap, are not eligible for this scholarship.



# Office of Sponsored Research

Cannot accept awards funding over 1.0 FTE salary

Had to resubmit budget to ACS without salary support



Rao, Saieesh

To: Moore, Heather

Wed 3/20/2024 3:17 PM

General

Rao - ACS Budget Template v2.xlsx
17 KB

Hi Heather,

Thanks for responding so promptly to the other thread!

Attached is the revised budget I submitted to ACS. It is not yet confirmed yet by ACS but hopefully can be used for OSR purposes to get things rolling. There is no salary support in the revised budget. I'll keep you posted with any changes or updates!

Best,
Saieesh