Introduction to NIH Funding

Richard Conroy, PhD
Office of Strategic Coordination
Office of the Director
NIH
NIH Overview

NIH’s mission is to seek fundamental knowledge about the nature and behavior of living systems and the application of that knowledge to enhance health, lengthen life, and reduce illness and disability.
Application Process

- Applicant (institution) submits to a funding opportunity announcement (either a specific solicitation or parent announcement) electronically through Grants.gov.
- Application is assigned to one of the 27 institutes or centers.
Funding Opportunities and Activity Codes

• Each funding opportunity announcement (FOA) uses a specific activity code

• Research project grants
  ▪ Provide funds to conduct a research study
  ▪ R series = R01, R34, R21, R03

• Training and career development awards
  ▪ Provide funds to conduct research + gain training
  ▪ F = Individual pre/post-doc fellowships
  ▪ T = Institutional pre/post-doc fellowships
  ▪ K = Mentored career development awards
R = Research Grants

• **R03 Small Research Grant**
  - Often secondary data analyses
  - Up to 2 years, $50K direct costs per year

• **R21 Exploratory/Developmental Research Grant**
  - “High risk, high impact”; feasibility studies
  - Up to 2 years, $275K direct costs total

• **R01 Research Project Grant**
  - Large research projects; often efficacy trials
  - Up to 5 years, up to $500K direct costs per year
New and Early Stage Investigator Policy

Under this policy:

• Applications to traditional R01 programs from New Investigators are segregated to the extent possible so that they can be reviewed in relationship to applications from other New Investigators.

• NIH ICs are required to maintain comparable award rates for new applications from both Experienced and New Investigators.

• Approximately half of the awarded New Investigators should be Early Stage Investigators.

Other Special Initiatives

High-risk, high-reward programs
- NIH Director’s New Innovator Award (DP2)
- NIH Director’s Early Independence award (DP5)

Next Generation Researchers Initiative
- Early Established Investigator (EEI): An EEI is a PD/PI who is within 10 years of receiving their first substantial, independent competing NIH R01-equivalent research award as an ESI. A meritorious application with a designated PD/PI EEI may be prioritized for funding if:
  - The EEI lost or is at risk for losing all NIH research support if not funded by competing awards this year, OR
  - The EEI is supported by only one active award.
Finding Funding – Solicited Applications

https://grants.nih.gov/funding/index.htm
Unsolicited (investigator-initiated) applications

Parent Announcements (For Unsolicited or Investigator-Initiated Applications)

Parent announcements are broad funding opportunity announcements allowing applicants to submit investigator-initiated applications for specific activity codes. They are open for up to 3 years and use standard due dates.

Not all NIH Institutes and Centers participate on all parent announcements. Before submitting your application, make sure the NIH Institute or Center that might be interested in your research is listed as a participating organization in the announcement.

The following Parent Announcements are available (sorted by Activity Code):

[ Research (R) | Research Training (T) | Career Development (K) | Fellowships (F) | Admin Supplements | Post-award Administrative Action ]

<table>
<thead>
<tr>
<th>Activity Code(s)</th>
<th>Title</th>
<th>Announcement Number</th>
<th>Issuing Organization</th>
<th>Release Date</th>
<th>Opening Date (SF424 Only)</th>
<th>Expiration Date</th>
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NIH RePORTER
NIH Peer Review System

First Level of Review
CSR or Institute
Scientific Review Group
Reviewed for Scientific Merit

Second Level of Review
NIH Institute/Center Council
Recommends Funding
Study Section Meetings

Before the meeting:
- Each application is assigned to 3 or more reviewers 5-6 weeks in advance

Reviewers assess each application by providing:
- A preliminary Overall Impact score
- Criterion Scores for each of the 5 Core Review Criteria
- A written critique
Review Criteria

Overall Impact
- Assessment of the likelihood for the project to **exert a sustained, powerful influence on the research field(s) involved.**

Core Review Criteria
- Significance
- Investigator(s)
- Innovation
- Approach
- Environment

Review criteria each scored from 1-9
Early Career Reviewer Program

The goals of the ECR Program are to:

- Train and educate qualified scientists without prior CSR review experience so that they may develop into critical and well-trained reviewers
- Help emerging researchers advance their careers by exposing them to a peer review experience
- Enrich the existing pool of NIH reviewers

http://public.csr.nih.gov/ReviewerResources/BecomeAReviewer/ECR/Pages/default.aspx
Grant Writing Tips

Be a “problem solver”
- Define a significant health problem and research gap
- Propose a hypothesis test to address the problem/gap
- Underscore how this work advances the field

Position this study as one step on the path forward
- Strategically indicate what research might come next.
- Work backward from a trial concept. What prelim data is needed now, to prepare for a future trial/study?

Align your research w/ funding institute priorities
- Read NIH Funding Opportunity Announcements
- Look at NIH Institute strategic plans, where available
- Communicate with NIH staff
Study feasibility is a common concern - reassure reviewers about it.

- **Present strategic preliminary data** (e.g., “our team has previously demonstrated the ability to enroll this highly-select sample in the specified time frame…”)
- **Consider turning worries into questions.** Make them a study aim? (e.g., “we will compare the feasibility and utility of two methods to recruit this highly-select sample.”)

- Consider briefly addressing “study limitations” at the end of the application
This is a Team Process!

• Plan research teams strategically
  ▪ Early-career PI should partner w/ more-experienced Co-Is
  ▪ Have all necessary expertise on-board
  ▪ Ideally, each team member contributes unique expertise

• Ask mentors for successful/unsuccessful grants and their review statements; learn from them

• Get feedback on your concepts/proposals
  ▪ Utilize mentors; talk with peers; offer to help each other!
  ▪ Send research concepts to NIH program officers
Remember to Contact Your Program Officer

• Preferably by email first!

• BEFORE you submit your grant
  ▪ To identify appropriate FOAs
  ▪ To discuss your idea & its suitability
  ▪ To discuss how to best “sell” your idea

• AFTER you get your summary statement
  ▪ To discuss the review
  ▪ To discuss how – and whether – to revise
Grants Basics

Before getting started, learn why it is important to understand the structure of NIH and how we approach grant funding, what types of organizations and people are eligible to apply, what we look for in a research project, and the types of grant programs we offer.
Research Training & Career Development Awards at NIH

• Rebecca Campo, Ph.D.
  • Program Officer
  • National Heart, Lung, and Blood Institute
What Type of Grant Mechanism is Appropriate for Your Career Stage?

Graduate Student
- F31 or T32

Medical Student
- T35
- F30

Ph.D.
- F32 or T32
- K99/R00
- K01 or K25

Faculty Position
- R01
- F33, K24 or K25

M.D. Clinical Training
- K08 or K23

Faculty Position

Independent PI

National Heart, Lung, and Blood Institute
### Spectrum of Research Training & Career Development Awards

<table>
<thead>
<tr>
<th>Graduate and Medical School</th>
<th>Postdoctoral Training</th>
<th>Transition to Independence</th>
<th>Established Investigator</th>
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<tr>
<td>T32 Institutional award</td>
<td></td>
<td>K01</td>
<td>F33</td>
</tr>
<tr>
<td>T32 Minority Institutions</td>
<td></td>
<td>K08</td>
<td></td>
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<tr>
<td>F30 Dual-Degree</td>
<td></td>
<td>K23</td>
<td></td>
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<tr>
<td>F31 Minority students &amp; individuals with disabilities</td>
<td>F32 Individual award</td>
<td>K25</td>
<td>K24</td>
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<tr>
<td>T35/R25 Short-term training institutional award for minority students</td>
<td>T32 Institutional award</td>
<td>K99/R00</td>
<td>K25</td>
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<tr>
<td></td>
<td>T32 Minority Institutional award</td>
<td>K12 &amp; KL2 Programs</td>
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Diversity and Re-entry Supplements to Grants and Contracts

**NIH** National Heart, Lung, and Blood Institute
Career Development (K) Awards…
Early Career Development Awards

Goal: To transition post-docs or junior faculty into successful R01 investigators by:

- Providing training needed for a research career
- Supporting career development activities
- Protecting time and effort for persons in early stages of research career
K Award Parent Announcements (PAs)

- **K01** - Mentored Research Scientist Career Development Award – open to PhDs.
- **K08** - Mentored Clinical Scientist Research Career Development Award
- **K23** - Mentored Patient-Oriented Research Career Development Award
- **K25** - Mentored Quantitative Research Career Development Award open to computational scientists with minimal biomedical training
- **K99/R00** - Pathway to Independence Award
K Award Eligibility

- Citizen, Permanent Resident, or Non-Citizen National of the United States
  - Applies to K01, K08, K23, and K25

- Citizens or Non-Citizens with no more than 4 years of postdoctoral research experience and not holding an independent research position
  - Applies only to K99/R00
K01, K08, K23, K25 Basics

- **3 to 5 Years** of Mentored Research Training
- Salary (NHLBI has a $100K cap) plus Fringe Benefits for Protected Time
- 25-50 K/year for Research Development
- **75% effort or more** required for K activities with some exceptions
K99/R00 Basics

- **1 to 2 Years** of Mentored Research Training in the **K99 phase**
  - Salary (NHLBI has a 100K cap) plus Fringe Benefits for Protected Time
  - 25K/year for Research Development
  - 75% effort or more required for K activities with some exception

- **3 Years** of Research Support in the **R00 Phase**
  - If a tenure-track Assistant Professorship or equivalent position is secured
  - Reviewed by Institute Staff
## Review Criteria

<table>
<thead>
<tr>
<th>Fellowships (Fs)</th>
<th>Career Development Awards (Ks)</th>
<th>Research Project Grants (Rs)</th>
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<tbody>
<tr>
<td>Applicant</td>
<td>Candidate</td>
<td>Significance</td>
</tr>
<tr>
<td>Sponsors, Collaborators, and Consultants</td>
<td>Career Development/Career Goals &amp; Objectives</td>
<td>Investigator(s)</td>
</tr>
<tr>
<td>Research Training Plan</td>
<td>Research Plan</td>
<td>Innovation</td>
</tr>
<tr>
<td>Training Potential</td>
<td>Mentor(s), Co-Mentor(s), Consultant(s), Collaborator(s)</td>
<td>Approach</td>
</tr>
<tr>
<td>Institutional Environment &amp; Commitment to Training</td>
<td>Environment &amp; Institutional Commitment to the Candidate</td>
<td>Environment</td>
</tr>
</tbody>
</table>
NIH Web Page for Research Training & Career Development Awards

- [https://researchtraining.nih.gov/programs/career-development](https://researchtraining.nih.gov/programs/career-development)
Scroll down to find a link to a list of NHLBI supported Training Programs
Tips from NHLBI

Rebecca Campo, PhD
Program Director
National Heart, Lung, and Blood Institute

NIH/MD2K Technology Showcase
June 4, 2018
Four Mission-Aligned Strategic Goals

**Promote Human Health**
To expand knowledge of the molecular and physiological mechanisms governing the normal function of HLBS systems as essential elements for sustaining human health.

**Reduce Human Disease**
To extend our knowledge of the pathobiology of HLBS disorders and enable clinical investigations that advance the prediction, prevention, preemption, treatment, and cures of human diseases.

**Advance Translational Research**
To facilitate innovation and accelerate research translation, knowledge dissemination, and implementation science that enhances public health.

**Develop Workforce and Resources**
To develop and enable a diverse biomedical workforce equipped with the essential skills and research resources to pursue emerging opportunities in science.
How NHLBI Establishes Scientific Priorities

- Mission statement
- Strategic Vision & Goals
- Portfolio Analyses
- Gaps in Science

**Other Factors**

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<thead>
<tr>
<th>Factor</th>
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<tbody>
<tr>
<td>Feasibility</td>
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<tr>
<td>Innovation</td>
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<tr>
<td>Multidisciplinary Nature</td>
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<tr>
<td>Potential impact on individual health</td>
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<tr>
<td>Potential impact on national health care expenditures</td>
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<tr>
<td>Potential impact on population health</td>
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<tr>
<td>Qualifications and track record of the proposer</td>
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<tr>
<td>Quality of proposed methods</td>
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<tr>
<td>Quality of writing and organization of proposal</td>
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<tr>
<td>Relevance to global agenda</td>
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<tr>
<td>Relevance to mission and strategic plan</td>
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<tr>
<td>Research need/Lack of studies</td>
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<tr>
<td>Study cost</td>
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<tr>
<td>Uniqueness or timeliness of opportunity</td>
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</table>

Bild D and Lauer M. JACC 2009;53:2259-61
Be in the Know

- Become familiar with the websites of those Institutes who might fund you

  AND

- Sign up for the NIH Guide ListServe

  http://grants1.nih.gov/grants/guide/listserv.htm

  once a week Table of Contents with ‘links’ to PAs, Notices, and RFAs

Pay Attention to Notices!
New!: NHLBI Policy on Clinical Trials Applications – All Investigators (ESI, NI, EI)

- Single site clinical trials: https://grants.nih.gov/grants/guide/pa-files/PAR-16-405.html and


NCMRR/NICHD
Funding Opportunities

Theresa Cruz, PhD
National Center for Medical Rehabilitation Research
NIH Research Plan on Rehabilitation

1) Rehabilitation Across the Lifespan
2) Community and Family
3) Technology Use and Development
4) Research Design and Methodology
5) Translational Science
6) Building Research Capacity and Infrastructure

Specific Funding Opportunity Announcements

• Research To Address Sleep Disorders in the Context of Medical Rehabilitation (R01): March 29, 2019
• NICHD Research Education Programs (R25): May 25, 2019
• NCMRR Early Career Research Award (R03): March 29, 2019
• Research on the Mechanisms and/or Behavioral Outcomes of Multisensory Processing (R01)
• Bioengineering Research Grants (R01)
Demystifying the NIA Process

NIH/MD2K
Technology Showcase

Lyndon Joseph
NIA Program Officer
June 4, 2018
NIA’s Mission: To improve the health and well-being of older Americans through research

- Support and conduct high-quality research on:
  - Aging processes
  - Age-related diseases
  - Special problems and needs of the aged

- Foster the development of research and clinician scientists in aging.

- Develop and maintain state-of-the-art resources to accelerate research progress

- Disseminate information on health and research advances and on new directions for research
NIA Strategic Directions for Research on Aging
https://www.nia.nih.gov/about/aging-well-21st-century-strategic-directions-research-aging

- **Understanding the Dynamics of the Aging Process**
  - **GOAL A:** Better understand the biology of aging and its impact on the prevention, progression, and prognosis of disease and disability
  - **GOAL B:** Better understand the effects of personal, interpersonal, and societal factors on aging, including the mechanisms through which these factors exert their effects.

- **Improving the Health, Well-Being, and Independence of Adults as They Age**
  - **GOAL C:** Develop effective interventions to maintain health, well-being, and function and prevent or reduce the burden of age-related diseases, disorders, and disabilities.
  - **GOAL D:** Improve our understanding of the aging brain, Alzheimer’s disease, related dementias, and other neurodegenerative diseases. Develop interventions to address Alzheimer’s and other age-related neurological conditions.
  - **GOAL E:** Improve our understanding of the consequences of an aging society to inform intervention development and policy decisions
  - **GOAL F:** Understand health disparities and develop strategies to improve the health status of older adults in diverse populations

- **Supporting the Research Enterprise**
  - **GOAL G:** Support the infrastructure and resources needed to promote high quality research.
  - **GOAL H:** Disseminate information to the public, medical and scientific communities, advocates and patient organizations, and policy makers about research and interventions.
NIA Organization

Office of the Director

Division of Extramural Activities

Division of Behavioral & Social Research
Caregiver issues, Risk Factors, Health systems, Demography/Economics, Resilience, Decision making, Self-management, Technology/Remote Care, Robotics, Transitions of Care

Division of Aging Biology

Division of Geriatrics & Clinical Gerontology
Robotics/Technology, Multiple Chronic Conditions, Falls/Biomechanics/Gait, HIV/AIDS, Musculoskeletal, Menopause, Frailty, Pain/Palliative Care, Physical Function/Exercise, Transitions of Care/Caregiver

Intramural Research Program

Division of Neuroscience
Alzheimer's/Dementia, Sensorimotor Systems, Sleep, Cognitive Health, Basic Neurobiology, Delirium, Technology/Monitoring, Robotics
Smart and Connected Health
Aspiring PIs

Wendy J. Nilsen, PhD
Program Director, Smart and Connected Health,
Directorate for Computer & Information Systems,
National Science Foundation
Sciences

- Computing
- Psychology
- Neurosciences
- Medicine
- Engineering
- Mathematics
“Sometimes I think the collaborative process would work better without you.”
**Goal:** To support the development of technologies, analytics and models supporting next generation health and medical research through high-risk, high-reward advances

- Work must include & address:
  - A key health problem
  - Address science and technology research gaps
  - Include a research team with appropriate expertise in the major areas involved in the work

- Activities should **complement** rather than duplicate core programs of NSF & NIH as well as those of other agencies (ex. Agency for Healthcare Research and Quality / Veteran's Administration)
✓ Take a coordinated approach that balances theory with evidenced-based analysis and systematic advances with revolutionary breakthroughs;

✓ Seek cross-disciplinary collaborative research that will lead to new fundamental insights; and

✓ Encourage empirical validation of new concepts through research prototypes, ranging from specific components to entire systems.
To transform health:

- from individual data to connected people and systems
- from experienced-based to data- and evidence-driven
- from health care to health that extends to the home, workplace and community
- Move focus from devices to connections between data, devices, systems and people
Smart Health Research Areas

**Health Information Infrastructure**
- Integration of EHR, contextual, clinical and patient data
- Access to information, data linkages
- Tools to enhance smart health research

**Connected Data**
- Heterogeneous and messy data
- Data fusion and optimization
- Datamining, machine learning, deep learning
- Inference, visualization, decision support system

**Connected Systems**
- Closed and human-in-the-loop systems
- Tools for connecting systems within systems
- Enhancing knowledge flow across the entire system

**Connected People**
- Enhancing communication between providers, patients and caregivers
- Assistive technologies embodying computational intelligence
What NOT to do!

**The following will likely result in a declined proposal:**

- Intellectual merit is exclusively focused in health/health care
  - SCH requires transformative advancements in computer science, engineering, behavioral and/or social sciences inspired by a need in health or healthcare

- Collaborations with medical providers who have no experience in research
  - Appropriate research collaborators are key to integrating technical advancements with challenges in the health field

- Proposal is written by yourself and health collaborator is only consulted just prior to submission
  - Proposed research should be influenced by health collaborators from its inception!

- Propose clinical trials or traditional disease-centric medical, clinical, pharmacological, biological, or physiological studies
Review Process

START

Organization Submits Proposal

Proposal Meets NSF Submission Criteria?

YES

Program Officer and NSF/NIH Division Leadership Conduct Review Analysis & Make Funding Decisions

Proposal Assignment & Data Entry

External Panel Proposal Review: See Review Criteria

Proposal Distribution & Verification

Proposed to be Funded?

NO

Notice of Decline: Reviewer Comments & Panel Summary Provided

Program Officer and NSF/NIH Division Leadership Conduct Review Analysis & Make Funding Decisions

YES, by NSF

Notice of Award: Reviewer Comments & Panel Summary Provided

PI Resubmits Original Proposal in NIH Application Format

Award Implementation & Post-Award Reporting

NIH Counsel Approval

YES, by NIH

Notice of Award: Reviewer Comments & Panel Summary Provided

Award Implementation & Post-Award Reporting

END

Proposal Not Accepted by FastLane or Returned Without Review

NO
Examples of Funded SCH Work
Large-Scale Probabilistic Phenotyping Applied to Patient Record Summarization

PI: Noemie Elhadad, SCH

Technical Approach:
- **Uphenome**: unsupervised probabilistic graphical model, where phenotypes (latent variables) are learned as a mixture of observed patient observations (free-text notes, meds, labs, diagnosis codes...)
- **Gphenome**: Uphenome + grounded phenotypes through informative priors, as determined through existing knowledge bases
- **Temporal phenotyping**: joint survival analysis that models multiple patients and multiple diseases; scalable variational inference algorithm applied to 13,000 patients and 8,800 conditions
- **Interactive visualization of phenotypes in patient timeline designed and validated through user-centered design**

Motivation:
- The electronic health record (EHR) contains a wealth of observations. There is a critical need for high-throughput phenotyping algorithms to help (1) study diseases, their progressions, and their interactions through time; (2) visualize and make sense of patient’s longitudinal records

Transformative:
- First attempt to learn jointly common phenotypes across large patient population (1,000 phenotypes; 350,000 patient records)
- Phenotypes are validated and used in a clinically meaningful task – patient record summarization and visualization, which mitigates information overload at the point of patient care

Broader Impacts:
- The HARVEST patient record summarizer deployed and used daily by 1,000 clinicians monthly at NewYork-Presbyterian Hospital (NYPH)
- Beyond point of care use scenario, users include quality abstraction nurses; in a study focused on their workflow, use of HARVEST yielded 20-minute average time savings on patient review (2-hour process otherwise); 90% of quality abstractors in study adopted HARVEST as part of their workflow

Contacts:
- Noémie Elhadad, Columbia University

Example of learned phenotype for SLE

**lupus** **ana** **sle** **complement** **rheum** **anti** mg **ab** **rash** **absent** esr **ulcers** **igg** **plaque** **dna** **ab** **objection** **vit** **antibody** **systematic** **sida** **rheumatology** **c** **positive** **antimalarias** **metamucil** **prednisone** **c4** **complement** **c3** **complement** **esr** **rbc** **urine** **total** **hemolytic** **complement** **dna** **antibody** **igg** **crp** **random** **urine** **protein** **antibody** **antibodies** **urine** **protein** **random** **urine** **creatinine** **random** **urine** **creatinine** **710.0** **systemic** **lupus** **erythematosus**
Untangling Complex Diseases into Subtypes
PI: Suchi Saria, SCH

Motivation:
• Scleroderma, Lupus are examples of phenotypically heterogeneous diseases, and there are few proven solutions that predict an individual’s course.
• Data accumulated from routine clinical visits may help to better understand disease subtypes.
• Mature machine learning and statistical inference tools for leveraging electronic health data do not yet exist.

Transformative:
• Subtypes can help to improve delivery of care to individuals.
• Differences between subtypes can motivate new directions for basic medical research.

Broader Impacts:
• Developing computational tools for improving the effectiveness and efficiency of care in complex diseases through the use of electronic health data.
• Training PhD students and postdoctoral fellows in the application of statistical machine learning to medicine and health.
• Exposing undergraduates to high-impact, cross-disciplinary research.

Contacts:
• Suchi Saria
• Laura Hummers, Fredrick Wigley, Antony Rosen
• www.cs.jhu.edu/~ssaria/autoimmunedisease.html

Technical Approach:
• Probabilistic graphical models encode domain knowledge, and model uncertainty and dependencies between heterogeneous data.
• Inference algorithms allow reasoning about unobserved phenomena conditioned on the available data.

Progress:
• Developed the Probabilistic Subtyping Model (PSM) for discovering subgroups of individuals with similar disease activity trajectories using longitudinal clinical markers.
• Results from analyses using PSM have motivated new clinical investigations into differences in antibody expression across discovered subgroups.
From Critique to Collaboration: Rethinking Computerized Clinical Alerts

PI: Davide Bolchini, SCH

Motivation:
- Drug safety alerts are critical for patient safety but largely ignored by doctors during medication prescribing.
- Despite efforts to improve design and reduce alert fatigue, physicians continue to distrust computerized recommendations.

Transformative Outlook:
- To improve alerts, we must first look at how to improve the trust between physician and computerized advice.
- We explore the foundational principles of what physicians consider important when taking advice from peers.
- We use this knowledge to create novel designs for drug safety guidance that elicit physician trust and a sense of collaboration.

Broader Impacts:
- Potentially reduce the over 2M adverse drug events per year by improving the safety of drug prescribing.
- Translating findings to inform EMR systems design through the Regenstrief Institute.
- Spread adoption to industry with EHR vendors and NIST.

Technical Approach:
- Formative field studies in clinical settings to unearth key factors in sharing trusted advice among doctors when prescribing drugs.
- Invent, design and deploy novel drug safety alert interfaces to convey drug safety information to providers in a more trusted manner.
- Evaluative sessions in the lab and with physicians in central Indiana hospitals to assess the physician’s user experience (UX) and effect of the proposed designs on alert compliance.

Progress:
- Completed field studies with physician hospital teams.
- Developed and evaluated 10 types of novel trust-based alerts.
- Discovered novel, more holistic metrics for alert effectiveness beyond binary compliance, aimed at supporting physician’s reflection and consideration of alternative courses of actions.

Contacts:
- Davide Bolchini (PI), Indiana University
- Jon Duke (Co-PI), Regenstrief Institute
- Eskenazi Health
- bit.do/trusted-alerts
Replicating Clinic Physical Therapy at Home: Touch, Depth, and Epidermal Electronics in an Interactive Avatar System

PI: Pamela Cosman, SCH

Technical Approach:
• Creating a cloud-based system for motion monitoring and a user interface for guidance
• Comparison of spatiotemporal trajectory of a given motion with that of a reference motion
• Development of flexible, adhesive-integrated antennas and sensors

Motivation:
• Physical therapy is crucially important for stroke patients; often slowed by poor adherence to home therapy regimens
• Goal: develop a home-based system that integrates unobtrusive wireless sensors with avatar rendering and machine learning
• Provide effective guidance for patients and caregivers

Transformative:
• Epidermal electronics like a temporary tattoo
• Hand and body pose estimation and tracking algorithms
• Cloud-based machine pose learning and avatar rendering algorithms

Broader Impacts:
• Assistive system useful for many healthcare training applications
• Finger tracking useful for sign language recognition
• Flexible electronics valuable for many types of physiologic monitoring

Contacts:
• Pamela Cosman, UC San Diego
• Todd Coleman, Sujit Dey, Sri Kurniawan, Truong Nguyen, Carter McElroy
• http://esdat.ucsd.edu/Mobile_Health_v2.html

Progress:
• Hand articulation tracking using an adaptive hand model
• Demonstration of adhesive-integrated flexible antenna on skin transmitting Bluetooth over 150 ft
• Dynamic alignment of motion sequences to evaluate motion correctness
• Study of finger force steadiness and repeatability

Cloud: Rendering, Analytics, Logic

Clinic: 3D Modeling

Home: Guidance on tablet

Patient exercises at home with cloud-based guidance
Useful Website: www.nsf.gov
Join our Listserv

- **SMARTHEALTH_COMMUNITY**

Join the electronic mailing list (LISTSERV) for forthcoming announcements by —
Sending an e-mail message to [LISTSERV@LISTSERV.NSF.GOV](mailto:LISTSERV@LISTSERV.NSF.GOV) from the mailing address at which you want to receive announcements.

The **body of the message** should read *Subscribe SMARTHEALTH_COMMUNITY [your full name]*.

The message is case sensitive; so capitalize as indicated!

- Don't include the brackets.
- The Subject line should be blank
- For example, for Robin Smith to subscribe, the message would read
  
  *Subscribe SMARTHEALTH_COMMUNITY Robin Smith.*

You will receive a confirmation of your subscription along with instructions on using the listserv.
Effective Research is a Relay between basic and applied science
Questions or Comments?

Wendy Nilsen
Program Director, Smart and Connected Health
Directorate for Computer & Information Science & Engineering
National Science Foundation
Tel: 703-292-2568
Email: wnilsen@nsf.gov