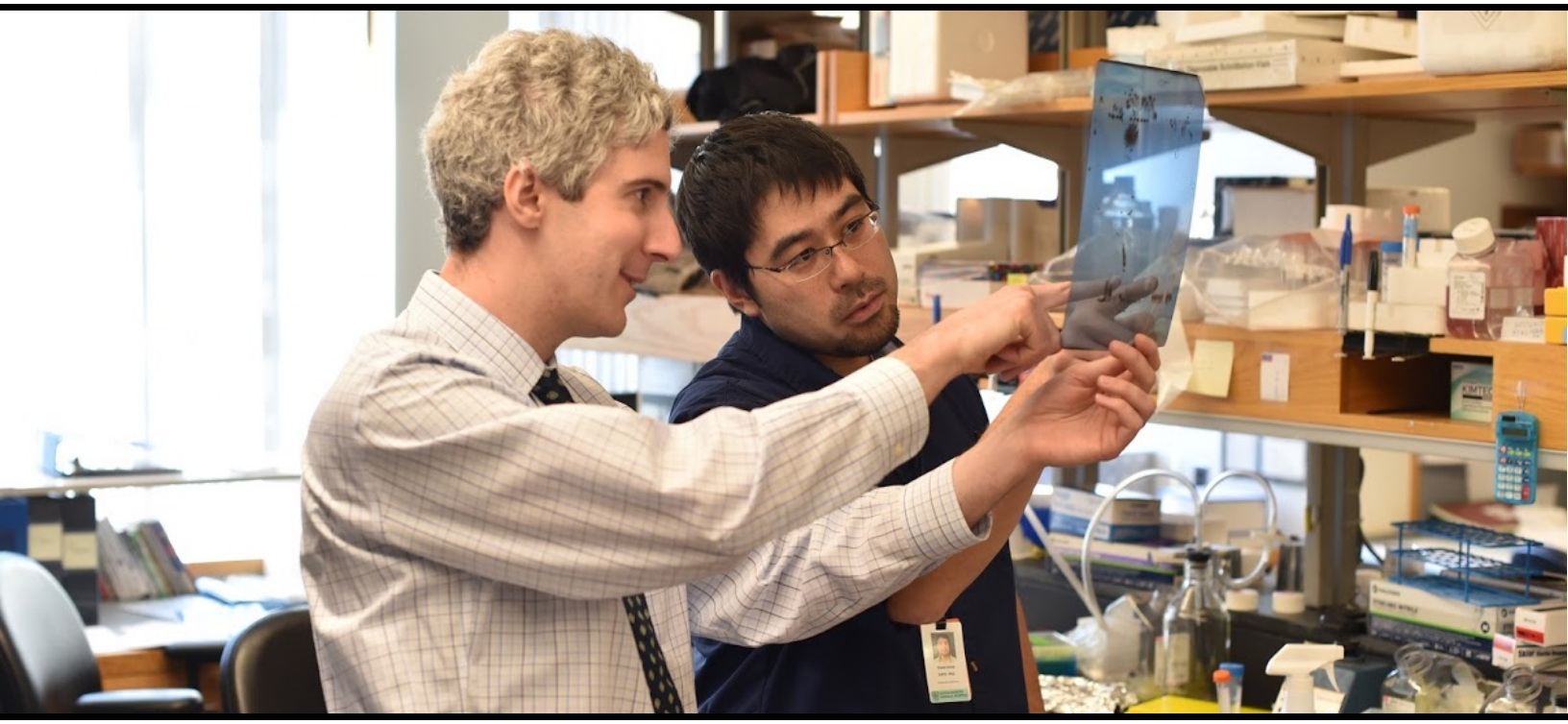
MASSACHUSETTS GENERAL HOSPITAL
DEPARTMENT OF MEDICINE

Medicine Innovation Program



Marc Wein, MD, PhD, and Tadatoshi Sato, PhD, studying signaling pathways that control bone formation.

Annual Report 2020-2021

Who we are

The Medicine Innovation Program is led by Director Christiana Iyasere MD, MBA and Project Manager Michelle Tagerman, MS, MPH.

Christiana Iyasere, MD, MBA is an attending physician within the Massachusetts General Hospital Department of Medicine's Division of General Internal Medicine and has spent the past 10 years involved in the active development of nascent technologies and therapeutics. She currently sits on the Partners Commercialization Council and has been instrumental in the development of multiple novel technologies from Mass General. She holds a BS from Yale University, an MD from Columbia College of Physicians and Surgeons, and an MBA from Harvard Business school.

Michelle Tagerman, MS, MPH is a Project Manager in the Massachusetts General Hospital Department of Medicine. Michelle has a background in health policy, healthcare management, and mental health research. She holds a BS and MS from Boston University and an MPH from Columbia University.

MIP 2021 and Beyond

Over the past five years we have seen the importance of supporting early stage innovation to the development of transformational medical technologies and the careers of physicians within the Department of Medicine. Investing in nascent technologies is not without risk, however the potential to translate important science into successful patient solutions is no greater than here at the frontlines of medical care and active scientific investigation.

We have learned how to be efficient in the deployment of capital and the crucial importance of recruiting and maintaining mentors and collaborators to the MIP pipeline.

Over the next several years our mission will not change, however we hope to expand the depth of our support and craft a very specific role within MIP to grow technologies that promote equity in healthcare.

If you have been part of our work thus far, we thank you. If you are interested in hearing more about how to contribute to the MIP mission, please do not hesitate to reach out, we are always on the look out for talented individuals to further our efforts.

Be well.

Christiana Iyasere, MD, MBA
Director, MGH Medicine Innovation Program

Medicine Innovation Program

The Massachusetts General Hospital Department of Medicine Innovation Program was formed in 2015 and is charged with accelerating the development and introduction of broadly applicable innovative ideas and cost effective technologies into the patient/provider community. Our work spans the creation and development of novel information technology, care delivery innovations and new therapeutics (drugs/devices) that can dramatically impact patient care. The Medicine Innovation Program provides the necessary resources in expertise, collaborations, seed funding and business development to ensure that chosen projects reach successful inflection points for ongoing, sustainable development.

We work to create sustainable solutions.

Why this matters

We support projects that are at a key inflection point in their development; there is plausible data to suggest that it will work, but generally not enough to garner significant outside grant funding or private sponsorship. We believe it is at this critical time that MIP can have the most impact in supporting nascent, but promising technologies.

Who supports risky projects, with the potential to transform medical care?

We do.

How do we truly leapfrog current technologies and therapeutics if we are bound to the traditional models of funding?

We aren't bound.

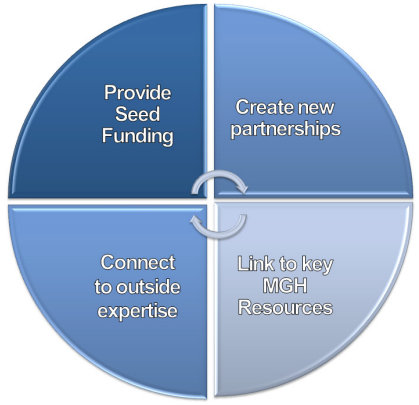
How we work

Catalytic Seed Funding, Mentorship and Expertise

The Medicine Innovation Program brings best in class expertise both within and outside of Mass General to develop ideas from Mass General Primary Investigators. The project and the PI and team are the center of focus of our work; each project we take on has unique needs and we are committed to bringing best of class expertise in business development, regulatory consultation and therapeutic development to bear on our projects based on need.

We are able to do so based on an expansive collaborative network both inside and outside Mass General. Similarly, we believe in the power of "smart money"; limited, catalytic funding to move a project with tentative POC data to its next inflection point to demonstrate feasibility as a product that can affect patients. Catalytic funding in conjunction with extensive, ongoing mentorship of our grant recipients allows us to both accelerate technology development and create transformative solutions with limited infrastructure requirements.

Catalyctic Activities



Advisory Board & Reservoirs of Expertise

Engines of innovation within MGH and the Boston Community

We leverage and build on the existing resources within Mass General to support a diversity of projects with in depth expertise. Both the Medicine Innovation Program and individual projects within our portfolio are advised by an internal group of Mass General physicians with demonstrated expertise in early stage technology development, and several engines of innovation within Mass General and in the Boston Community:

- **MGB Innovations**
- **MGH Healthcare Transformation Lab**
- **MGH Research Institute**
- **Harvard Business School**
- **MIT LinQ Converter Program**
- **MGB Connected Health**
- **MGH Springboard Studio**
- **Third Rock Ventures**
- **MGH Vaccine and Immunotherapy Center**

What we do

Medicine Innovation Program Development Paradigm

Our approach takes research projects with the potential to transform medicine and provides them with the needed resources to move them forward to the next inflection point in successful solution development. Resources provided include structured project management support, milestone based stewardship of resources, focused mentorship and access to networks that can move the project to the next step in development. The goal is to move from a project to a product that can be consumed and used by patients and providers.

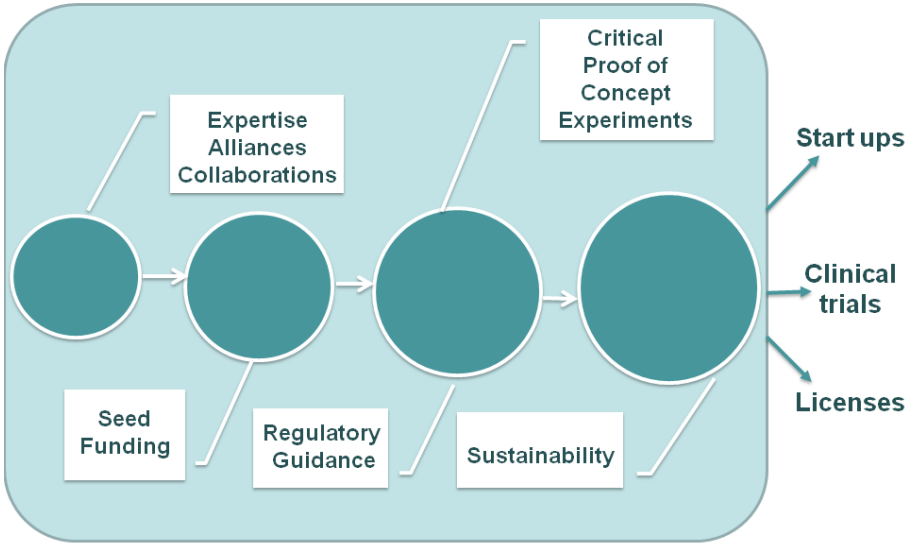
Upon exiting the Medicine Innovation Program, successful projects are ready to transition to:

- **External partnerships with private industry via licensing or start-up**
- **Subsequent follow-on grant funding**
- **Larger adoption and consumption within the MGB infrastructure**

The Medicine Innovation Program actively supports projects for 12-18 months depending on the needs of the project and project team.

Each project in our portfolio goes through a similar development process, although the specific milestones and accomplishments are based on the needs of the project itself and the goals of the primary investigator.

Development Paradigm



Medicine Innovation Program RFP

A Diverse Portfolio, High Potential Impact

Projects are chosen via a yearly competitive RFP process within the Mass General Department of Medicine. Projects and primary investigators are judged on the potential of the project impact/change care, and preparedness of the team to execute on milestones within the tenure of Medicine Innovation Program support. RFP finalists are invited to present their work to the Medicine Innovation Program Advisory Board; this allows the program to both vet the idea and get to know the Primary Investigator to ensure a fit with the Medicine Innovation Program. Which grant an awardee receives is based on the project stage of development.

We provide two different types of awards based on project need and stage of development. SPARK awards are for projects just getting started that need linkages to critical resources and a limited amount of money to test a hypothesis. Our larger MIP granting program supports projects which have demonstrated some degree of previous success – either with limited data from the lab or previous focused implementation of a redesign that is ready for larger adoption. The MIP RFP is designed to help these projects determine if the idea is viable and to gain sufficient data for follow-on funding.

SPARK
- Catalytic seed funding to start an initiative and test fundamental principals
- Mentorship, expertise & advisors
- 12 months

MIP RFP
- Annual to all DOM
- Monetary support for POC studies, tech build
- Mentorship, expertise, advisors
- 12-18 months

Psychological Intervention Application for Patients with Acute Myeloid Leukemia: DreAMLand

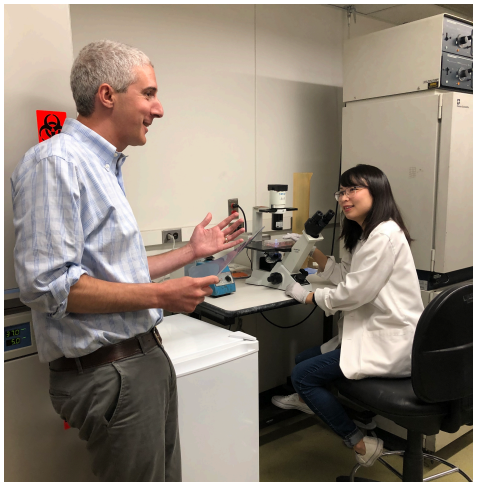
After seeing firsthand the struggles patients face after a sudden, life threatening diagnosis of Acute Myeloid Leukemia (AML), Areej El-Jawahri, MD, found that psychological interventions to promote effective patient coping skills during this critical time were lacking. Upon diagnosis, most patients with AML are immediately hospitalized for initiation of 4-6 weeks of intensive chemotherapy and are generally unable to see friends and family in person due to their immunosuppressed state. Through the trauma of the diagnosis and the ensuing treatment, patients often endure a host of physical and psychological symptoms including uncertainty regarding the prognosis, social isolation during the hospitalization, and a complete loss of independence that can result in decreased quality of life and ultimately survival outcomes. To find a potential solution, Dr. El-Jawahri looked to a mobile application as a way for her patients to find out information about their diagnosis, connect with other patients, and relieve some of the psychological stress associated with the disease. A mobile application provided a unique solution that allowed for broad dissemination and gave patients who are stuck in the hospital for prolonged periods of time with feelings of no control to "do something," to help their situation. Her self-administered mobile app, DreAMLand, provides supportive psychotherapy, psychoeducation, psychosocial skills building and self-care promotion in the form of a game where a patient is “abducted by an illness” and navigates though a journey that mimics their own clinical experience. Through the mobile application journey, the patient stops at different stations along their clinical course and is able to learn facts about AML, their treatment regimen, and play stress relieving games based on established supportive psychotherapy methods. With funds from her 2017 MIP Grant, Dr. El-Jawahri built an initial prototype of her app for use in a pilot randomized controlled trial to assess feasibility and preliminary efficacy of the device. Patients and caregivers resoundingly embraced the application, with many of them asking to use it outside of the study itself. The app has gone on to be used at multiple academic medical institutions, and in 2020, DreAMLand was licensed to Blue Note Therapeutics, a prescription digital therapeutics company dedicated to the transformation of mental health care for cancer patients.

"I am immensely grateful for MIP support that helped me initiate a line of investigation utilizing digital therapeutics to improve the quality of life and care for patients with blood cancers. Since my MIP award, I have developed six digital mobile apps building on our experience with DreAMLand, secured funding through foundations and the NIH to support our research program, and licensed the DreAMLand application to a private entity with the goal of making it available to all patients that would benefit."

Preclinical development of YKL-05-099, a new osteo-anabolic small molecule to treat osteoporosis

Marc Wein, MD, PhD, a MIP 2017 awardee, used funds from his grant to evaluate the efficacy of a novel bone building therapy for osteoporosis. Osteoporosis is a major public health problem in our aging population. Most osteoporosis treatments work by slowing bone resorption, a strategy that does not fully restore skeletal integrity. The most commonly used bone building treatment is teriparatide, a synthetic version of parathyroid hormone (PTH). Teriparatide use is limited by the need for daily self-injections and risks of bone related cancer. Therefore, orally available medications that stimulate new bone formation represent a major unmet need in osteoporosis pharmacotherapy. Through mechanistic studies investigating how PTH stimulates new bone formation, Dr. Wein's laboratory found that YKL-05-099, a novel, orally-available small molecule kinase inhibitor mimics the actions of PTH in bone. Bone formation and bone mass are increased in mice treated with YKL-05-099 without obvious signs of toxicity. Therefore, YKL-05-099 represents a novel 'osteoanabolic' treatment strategy.

The work supported by MIP allowed Dr. Wein to test the efficacy and safety of this first-generation novel compound in mouse models. In these studies, they demonstrated therapeutic efficacy of YKL-05-099 in a 'gold-standard' preclinical model of post-menopausal osteoporosis without obvious toxicities.



Data generated was both published and led to further support for this project from the Harrington Discovery Institute, novel intellectual property claims, and a collaboration with the pharmaceutical company Radius Health to study next generation compounds. The in vivo efficacy data supported by the 2017 MIP award played a crucial role in catalyzing this project at an early stage.

"The 2017 MIP support was exactly what we needed to start moving from a discovery in the lab towards a therapy to bring to our patients with osteoporosis."

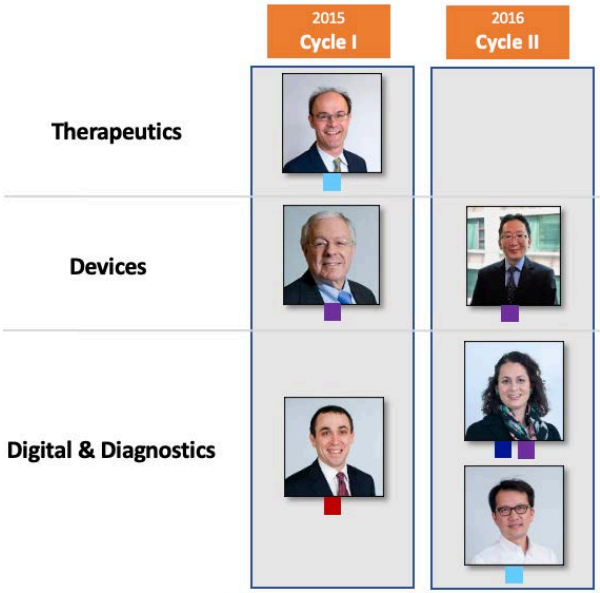
Monitoring, understanding, and guiding sunlight exposure using a wearable device in patients with erythropoietic protoporphyria, a severe form of cutaneous photosensitivity

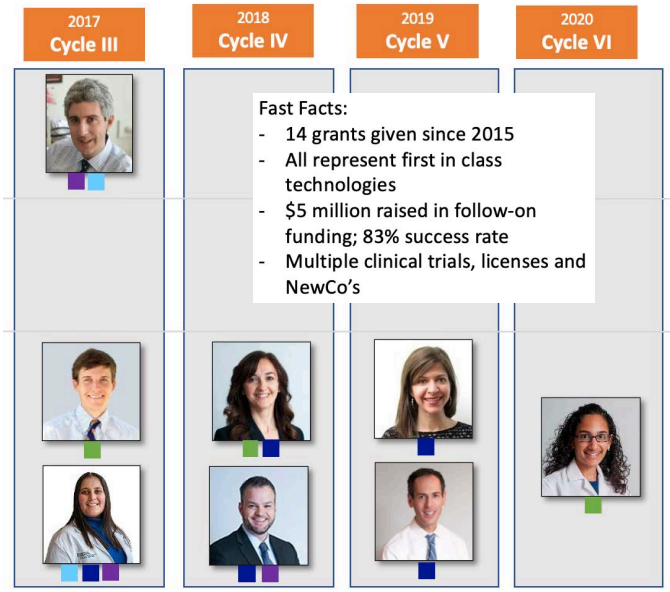
Cutaneous photosensitivity results from a heterogeneous group of disorders that drastically impair quality of life. Erythropoietic protoporphyria (EPP) is a severe inherited form of cutaneous photosensitivity which causes life-long painful cutaneous sensitivity to light. In EPP, both the mechanism of pain and the variability in light sensitivity between patients is poorly understood. Sunscreen is not effective because patients are sensitive to visible rather than UV light.

While new therapies are needed, the identification and validation of potential therapeutic targets has been fraught with difficulty due to a lack of quantitative disease monitoring tools and biomarkers of phototoxic reactions. To address these needs, Amy Dickey, MD, MSc, in the Division of Pulmonary and Critical Care Medicine, who herself has EPP, utilized an existing wearable device to measure light exposure to quantify the amount of sunlight exposure and symptoms in patients with EPP. This has the potential to help patients in several important ways: (1) Analyzing light exposure practices and the resulting symptoms to provide better insights into the pathophysiology of phototoxicity in EPP could inform the development of new therapies (2) Enabling EPP patients to make informed decisions about sunlight avoidance based on their accumulated light dose will improve quality of life (3) More accurate dosimetry of light exposure can improve data collection for clinical trials to facilitate the approval of new therapeutics for EPP. With MIP funds awarded, Dr. Dickey was able to launch a clinical trial evaluating a wearable light dosimeter for tracking exposure and symptoms in patients with EPP. Unpublished data from the study demonstrated that its measurements provide a better approximation of the patients' disease severity as compared to previous measures. Dr. Dickey is currently preparing publications of her study results. Her preliminary data resulted in her receiving both an NIH K23 grant and industry funding, which will allow her to test a more advanced light dosimeter in follow-up studies. While her project focuses on EPP, much of the knowledge gained from the study will also be transferable to other forms of photosensitivity.

"I decided to transition my career to focus on EPP at a time when I had no funding or preliminary data. At a key vulnerable transition point in my career, the MIP believed in my vision, providing both the funding and mentorship needed to launch my research in a new direction. I'm incredibly thankful to the MIP for believing in me when so many people told me to give up."

Our Portfolio





License/NewCo
In Clinical Trials
Follow-on Grants
In Development
Project Retired

Our Portfolio (cont.)

Digital Health

Allergy Passport: Digital Application for Medication and Food Allergies, Kim Blumenthal, MD, MSc, 2016 awardee

DreAMLand: Digital Application for Support of Patients with Acute Myeloid Leukemia, Areej El-Jawahri, MD, 2017 awardee

Smartphone App for Ascites Management: Mass General Brigham Connected Health Application to Facilitate Outpatient Management of Cirrhotic Ascites, Patricia Bloom, MD, 2018 awardee

Virtual Cardiac Rehabilitation Program Following Hypertensive Disorders of Pregnancy, Amy Sarma, MD, MHS, 2020 awardee

Artificial Intelligence

PROE PCI: Risk Assessment for Patient and Physician Prior to Cardiac Catheterization for Improved Decision Making, Jason Wasfy, MD, MPH, 2015 awardee

Clinical Data Visualization and Machine Learning: Deep Learning to Extract Useful Information for Clinical Decision Making, Tom McCoy, MD, 2017 awardee

Natural Language Processing in the Evaluation and Diagnosis of Irritable Bowel Syndrome, Kyle Staller, MD, MPH, 2018 awardee

Diagnostics

Day Zero Diagnostics: Diagnosis of Bacterial Species and Sensitivities Within Hours, Douglas Kwon, MD, PhD, 2016 awardee

SHERLOCK for STIs: Novel, CAS13-Based Point-of-Care Detection of STIs and Antimicrobial Resistance, Robert Goldstein, MD, PhD, 2019 awardee

Therapeutics and Medical Devices

Long Acting Parathyroid Hormone: First in Class Drug for Trreatment of Hypoparathyroidism, Michael Mannstadt, MD, PhD 2015 awardee

Laser Therapy for Treatment of Resistant UTIs: Novel Treatment of UTIs with Light Based Therapy, Jeffrey Gelfand, MD, 2015 awardee

Allergy Tolerance: Laser Therapy to Induce Immune Tolerance to Food Allergens: Satoshi Kashiwagi, MD, PhD, 2016 awardee

Novel Osteoporosis Therapy: New Oral Therapy for Osteoporosis, Marc Wein, MD, PhD, 2017 awardee

Digital Device for Porphyria Management and Diagosis: Smartphone-Based Digital Device for Measuring Photosensitivity in Porphrya, Amy Dickey, MD, MSc, 2019 awardee

Metrics of Success

- 12/14 projects represent **first in class drugs or technologies**
- 3/14 projects target **communities at risk**
- 5 projects in **clinical trials**
- Greater than $5 million in **follow-on funding** for supported projects
- **$15 return** for each $1 invested
- 1 **company**, 5 **commercial licenses**
- 3/14 PI's went on to become **Transformative Scholars**
- 5/14 projects supported **early career women faculty**

How Are We Doing?

Feedback from our award recipients:

- *"The project would not have happened without MIP funding."*
- *"MIP helps legitimize an idea that may be too innovative for traditional funding routes."*
- *"The impact of MIP on my project was huge, I wouldn't have been able to do it without it."*
- *"Although the initial funding amount was small, the support and mentorship were invaluable to kick start the work towards its current stage."*

Medicine Innovation Program Advisors

Our advisors are experts in their field and help drive our projects to succeed.

Organizational
Katrina Armstrong, MD, MSCE
Eric Isselbacher, MD
Paula McCree, MS
Joshua Metlay, MD, PhD

Scientific
Gabriela Apiou, PhD
Kim Blumenthal, MD, MSc
Areej El-Jawahri, MD
Jeffrey Gelfand, MD
Steve Grinspoon, MD
Mark Lindsay, MD, PhD
Tom McCoy, MD
Larry Miller, MD, MPH
Mark Poznansky, MD, PhD
H. Shaw Warren, MD

Feasibility
Martha Gray, PhD
Kristian Olson, MD

Business Development & Intellectual Property
Nimra Taqi, MS

Mass General Development
Alexandra Mikkelsen

Regulatory
Bruce Burnett, PhD

How You Can Participate

The Medicine Innovation Program is in active engagement with the Mass General community and looks for ongoing opportunities to support our work through collaborative engagements.

To learn more about the Medicine Innovation Program contact:
Michelle Tagerman, Project Manager, Medicine Innovation Program
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