Attachment—Additional Questions for the Record

Subcommittee on Health
Hearing on
"ARPA-H: The Next Frontier of Biomedical Research"
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The Honorable Frank Pallone, Jr. (D-NJ)

1. *Part of the proposed mission of APRA-H is "to make pivotal investments in breakthrough technologies and broadly applicable platforms, capabilities, resources, and solutions that have the potential to transform important areas of medicine and health."*

   This is a broad mission, but the Administration has identified specific examples of projects that ARPA-H is well suited to explore, such as "the development of accurate, wearable, blood pressure technology; the preparation of mRNA vaccines against common forms of cancer; and drug or gene therapy delivery systems that can target any organ, tissue, or cell type."

   a. *Could you provide some examples of platforms or technologies that have enabled transformative progress in biomedical research?*

Indeed, platform technologies underly the most important advances in medicine. These technological advances leverage discoveries made through basic and clinical research to drive new treatments and cures for human diseases and disorders. This is why the majority of Nobel prizes are awarded for the development of new technologies. Examples include the Moderna mRNA vaccine against COVID-19 (Originally funded in 2010 by DARPA). mRNA technology will eventually lead to vaccines against other infections including herpes and malaria, improved flu vaccines, and, if necessary, updated coronavirus vaccinations. Others include targeted cancer therapies, robot-assisted surgery, the use of artificial intelligence to detect sepsis, the MRI machine and, of course, the internet (ARPAnet, 1963).

   b. Can you provide examples of breakthrough technologies that draw from atypical disciplines and talk about why the flexibility envisioned by the ARPA-H model is important?

There are a host of examples, but to name a few: autonomous vehicles, 3D printing, stealth technologies, bioprinting, wearable and smart home technologies, and drones all drew from atypical disciplines to make advances that have fundamentally changed the world.

The key to the success of ARPA-H will be operating on the same nimble program model that DARPA has used for decades to advance technologies that draw from atypical disciplines. Had any of the aforementioned technologies solely relied on traditional grant programs used by other Federal agencies, we would not have seen them come to market at the pace they did. Nimble and flexible program decision making by skilled program managers is key to success because it allows them to pivot based on experience and dedicate dollars towards the most promising approaches rather than sticking with bets that are not panning out. For example, if ARPA-H was to rely on traditional peer reviewed granting mechanisms, review committees would rarely provide funding for high-risk high-reward projects necessary to swing for the fences. Instead, we would see incremental progress stretched over many more years. These funding mechanisms are great for discovery-based research that build slowly on the advances of others but are not well suited for invention and creation of new capabilities.

2. *There is an ongoing and healthy debate on the appropriate placement of ARPA-H. Generally, there is a consensus that ARPA-H will need an independent structure and novel culture, compared to traditional NIH Institutes and Centers, to deliver innovative ideas in health and medicine. After all, the success of DARPA, the model for ARPA-H, is in part due to its independent structure and innovative culture.*

    a. *In your testimony, you discuss the importance of independence for ARPA-H. What do you mean by that?*

Independence is essential to the success of ARPA-H. When President Eisenhower established DARPA, he was under pressure from the Departments of Army and Navy to place the agency inside one of those structures to avoid duplication of administrative, legal and operational functions. He resisted this pressure, recognizing that such institutional constraints would run counter to the core principles of DARPA's modus operandi: a culture of urgency, innovation and efficiency. Arguably, it was the most consequential decision Eisenhower made in setting DARPA up for success. His rationale and Congress' support for that decision are as important to ARPA-H's success as the rest of the DARPA model.

The inability of the *NIH Common Fund and the National Center for Advancing Translational Research* to reach their potential and yield life-saving innovations are the best examples of how unrealistic it is to locate a new priority initiative within the NIH – the largest biomedical research agency in the world – with the expectation it will operate with "independence" and "its own culture." With nearly $1B in annual budget and stated funding criteria for programs that are "Transformative; Catalytic; Synergistic; Cross-cutting and Unique," the *Common Fund* has not made progress in the development of technologies or capabilities that address critical gaps in diagnostics, therapeutics and curative treatments. Further, NCATS has been bogged down with bureaucratic burden that has limited their ability to use other transactional authorities with the kind of speed and efficiency required to drive rapid innovation.

It is not just about the research. At the very beginning of a project, DARPA demands that its performers address how they will transition their technology. Important

questions must be identified and addressed up front such as (1) regulatory strategy, (2) commercialization approach – who will make this, who will distribute it, who will service it and (3) how will providers and patients adopt it?

b. *If ARPA-H is placed at NIH, would it be able to develop a distinct culture?*

Placing ARPA-H within the NIH sends a message that this new agency is merely more of the same, with a different name and some new funding. ARPA-H must be free to develop its own culture of innovation, with its focus on getting advancements out of labs and into patients. The purpose of having ARPA-H independent of the NIH is to remove it from NIH bureaucracy. Placing ARPA-H in the NIH potentially subjects it to slow processes that are not designed for the purpose of running a DARPA-like agency. Operationally, ARPA-H needs the ability to eliminate bureaucratic processes so funds can be efficiently distributed to performers with the rigorous funding oversight and accountability that is a hallmark of DARPA's culture. Without this independence, ARPA-H would be subsumed by the NIH.

Additionally, it is important to note that DARPA doesn't own or operate its own research labs. It oversees and manages research conducted at universities, government labs, established industry R&D facilities and start-up companies. Notably, it is often the start-ups that innovate and work at the pace and focus needed to achieve meaningful timely advances in clinical care. For ARPA-H to succeed, industry must be highly engaged. The processes of manufacturing and distribution are critical to advancing these innovations into the clinical setting at facilities across the country. To facilitate this type of effort, ARPA-H should be independent and free.

c. *How do we ensure accountability and transparency while also providing for this autonomy and independence that is so important to the success of ARPA-H?*

Accountability and transparency need to be embedded in the operating policies and structure of the Agency, just as they are for DARPA. ARPA-H program managers must have control and responsibility for their projects and their performers. At DARPA, there is a contract clause that gives the government full rights to terminate funding for any reason without prior notice. This ensures that the performers execute their milestones within budget and on time. Additionally, DARPA typically executes milestone payable contracts. This means that the performers are not paid until they successfully achieve goals, which further ensures accountability.

ARPA-H must be accountable and transparent with the Congress as well. Because each program will have clear contractual milestones, timelines and budget, the Congress should be able to gauge each and every program's progress and success in real time. This kind of transparency and accountability is unheard of in the NIH world.

3. *Two key actors within DARPA, the model for ARPA-H, are the Director and program managers. Generally, the responsibility of the Director is to approve funding and programs, while program managers are expected to oversee project execution and performance. The Biden Administration's proposed structure for ARPA-H also includes a Director and program managers.*

    a. *Finding the right inaugural Director for ARPA-H will be critical to building a distinct culture and ultimately ensuring its success. What do you see as the key qualities for this individual? What type of track record and qualifications should they have and how will those be helpful in leading ARPA-H?*

The inaugural Director for ARPA-H must be an established leader with a track record of success using nimble contract-based models for research funding. Most importantly, the candidate must lead with the attitude and principles at the core of ARPA-H: innovation, efficiency, and accountability. The Director's ability to inspire inaugural program managers and all players in the ecosystem is essential. I believe that looking to an individual with previous experience at DARPA is a solid starting point for the new agency.

It is logical that if ARPA-H is modeled on DARPA that the inaugural leader would have senior DARPA leadership experience. Other qualifications should include a doctorate (PhD) in a technical area and, optionally, medical training (MD or DO). The Director must have experience in both government and private sector, with previous organizational leadership experience at equivalent levels to the ARPA-H Director. Background and strong working knowledge of the FDA regulatory process is also critical since many of the medical interventions developed through ARPA-H funding will be headed to regulatory review and should be designed and tested with that in mind. They should also have familiarity with medical product manufacturing and distribution, as well as clinical care operations to ensure that they have a firm understanding of the barriers to adoption by providers and patients.

    b. *The Director will need to be surrounded by the right team of program managers. What qualities are important for these program managers? How will ARPA-H recruit and retain these talented individuals?*

Under exceptional leadership, ARPA-H should attract the highest quality talent. DARPA's reputation as "the gold standard of innovation" will serve this agency's recruiting efforts if the leadership model and operating structure are the same. Program managers need to have deep experience leading teams (ideally across multiple disciplines), operating with accountability, meeting deliverables, and executing projects on time and on budget. They must be resilient and open-minded. For that reason, DARPA, and thus ARPA-H should be constantly recruiting new talent because it takes a special individual with an unusual set of skills, knowledge, and creativity to succeed in these roles. It is not just a matter of bringing in smart people.

c. *Can you talk about the diversity of scientific disciplines and backgrounds that program managers will need to approach health in new ways?*

Program Managers are talented and innovative thinkers who come from a broad range of backgrounds. ARPA-H program managers will necessarily have to have diverse expertise because the problems they will be tackling require a diverse set of approaches. For that reason, we are going to want people with backgrounds that range from medicine, to medical device experts, to data scientists, PH.D. biologists, physicists, engineers, chemists, mathematicians, social scientists, psychologists and technologists. The diversity of program directors must reflect the diversity of challenges that they are going to attack.

4. *The Office of Science and Technology Policy (OSTP) and NIH held a series of fifteen listening sessions with stakeholders across the biomedical ecosystem to seek input on ARPA-H. More than 5,000 individuals registered for these sessions, providing nearly 1,000 suggestions, ideas, and questions across the 15 sessions*

    a. *What input can or should stakeholders have in the selection of ARPA-H projects?*

One of the most critical distinctions between DARPA and the NIH is the process for project selection. Following the DARPA model, ARPA-H will not solicit ideas for funding the way NIH operates and funds proposals. Projects will be defined by "Solving for X." -- Identifying a gap in a capability (whose innovation could have broad application) and solving for it. ARPA-H will not focus on disease specific issues, but rather will identify what capability could be built that addresses the greatest challenges. The investments made by ARPA-H should reflect real healthcare needs and technological opportunity to address them.

    b. How should that input be incorporated and by who?

5. *Since DARPA is considered to be the model for ARPA-H, it might be helpful to hear more about its budget while keeping in mind that biomedical research tends to be expensive relative to other areas of technology R&D.*

    a. *Can you shed light on DARPA's operating budget? Are you aware of DARPA displacing any funds from other existing DoD capacities?*

DARPA's operating budget is about 4% of the total DoD research and development (R&D budget). DARPA's annual budget has remained relatively steady. The President's FY2022 budget request for DARPA is $3.528 billion. The FY2021 enacted budget was $3.500 billion. DARPA-funded research has made important science and technology contributions that have led to the development of both military and commercial technologies, such as precision guided missiles, stealth, the internet, and personal electronics. Nearly all of DARPA's funding falls under the budget categories of basic research, applied research, and advanced technology development 6.1, 6.2, and 6.3.

Commented [MS1]: This number is not correct. Is it .8%?

Funding under these categories is referred to by DOD as the science and technology (S&T) and research and development (R&D) budget.

DARPA is a separate line item in the President's DoD Budget that is proposed to the Congress every year. To my knowledge, I am unaware of DARPA displacing any funds from any other existing DoD capacities.

b. *Do you think the Biden's Administration's proposal of $6.5 billion over three years is an appropriate figure?*

Yes, I think that President Biden's proposed $6.5 billion over 3 years is an appropriate figure. DARPA's budget of $3.5 billion is relatively small compared to the total DoD R&D budget of $112 Billion. This funding ratio should exist for ARPA-H vis a vis the total HHS R&D budget. Once ARPA-H is well established, the congress will want to grow it substantially. Each dollar spent at ARPA-H, if it is functioning independently from the NIH, is a healthcare and economic bargain because the return on investment for the public will dwarf the expenditures.

6. *The ARPA-H proposal put forth by the Biden Administration identifies the Defense Advanced Research Projects Agency, or DARPA, as the model for ARPA-H. Since its founding in 1958, DARPA has supported crucial technological advancements in the interest of national security. And as you noted in your testimony, DARPA is the gold standard for innovation.*

    a. *Having served at DARPA for 11 years, could you help the Committee understand what you see as the key aspects of DARPA culture that made it successful?*

The key aspects of DARPA's culture that makes it successful are (1) risk taking attitude, (2) program manager empowerment, (3) strict oversight and accountability and (4) milestone driven timeline limited process of R&D execution, and (5) complete independence from traditional DOD bureaucracy.

A critical element of the DARPA culture is attention to the Heilmeier catechism. Dr. Heilmeier was a DARPA Director who developed a series of questions that every PM had to address when developing each new program. The Heilmeier catechism is: (1) What are you trying to do? Articulate your objectives using absolutely no jargon, (2) How is it done today, and what are the limits of current practice? (3) What is new in your approach and why do you think it will be successful? (4) Who cares? (5) If you are successful, what difference will it make? (6) What are the risks? (7) How much will it cost? (8) How long will it take? and (9) What are the mid-term and final "exams" to check for success?

Risk-taking culture. At DARPA, the culture is not only about risk taking but how that risk is managed. DARPA has a culture of risk-taking and tolerance for failure that

encourages radical innovation to solve a problem. DARPA focuses on high-risk, high-reward research. The goal is to discover how far the American scientific community can go. When a performer is unable to achieve a desired outcome, it is typically because the limits of current knowledge have been met. So by "failure" there has been important success: where the limit is and how to go beyond it. It is common knowledge that failure is often the best teacher. Risk is managed by the DARPA process itself, which at its heart is the program manager.

Program manager (PM) empowerment. The DARPA model is characterized by a flat organization that empowers its tenure-limited PMs with trust, autonomy, and the ability to take risks on innovative ideas. The PM is the source of the program idea. It is the PM who is responsible for program execution. It is the PM who has authority to "hire and fire" and to reallocate funding so as to ensure that the program is completed in an efficient and timely manner.

Congress has aided DARPA's efforts by granting the agency certain flexible acquisition and personnel hiring authorities, which have allowed DARPA to engage with people and entities that may have otherwise been reluctant to interact and do business with DOD. This model allows DARPA to avoid internal processes and rules that slow action in other federal agencies.

Since tenure is limited for each program manager, they have an impatience to accomplish their program's goals while they are still at the Agency. This ensures timely execution of the work by the performers.

Program managers play a key role in the technical direction of each project. Unlike most program managers in federal R&D agencies, DARPA program managers are tasked with creating new programs and projects and quickly funding innovative ideas. DARPA program managers are responsible for project selection and, if milestones aren't met, the termination of a project. In contrast, program managers from other federal programs such as NSF and NIH inherit existing programs and select projects based primarily on the peer review rankings.

Strict oversight. Because every program has clearly identified milestones and is on a strict timeline, program managers and the Congress can ascertain how well each program is progressing – in real time. The PMs typically meet remotely with performers on a weekly basis, in person every month, and have formal reviews quarterly.

Milestone driven and timeline limited process. DARPA awards contracts to performers. These contracts have mutually agreed upon milestones and timelines for the work. DARPA's culture is to adequately resource performers so they can execute the work in as short a time as possible. Of all resources, time is the most precious and is thus the one resource to be used sparingly.

Independence from DOD bureaucracy. If DARPA was part of the traditional DOD decision making bureaucracy, it would fall apart. It is independence from troublesome bureaucracy that allows the agency to remain nimble and take risks.

b. *How can ARPA-H apply those lessons to its distinct health-focused mission?*

DARPA attributes its long history of successful innovation to four factors: (1) Trust and autonomy; (2) Limited tenure and the urgency it promotes; (3) A sense of mission; and (4) Risk-taking and tolerance for failure. ARPA-H can apply these same factors to address critical health system issues that other Federal agencies cannot due to the nature of their funding mechanisms, investment management strategies, and major institutional and cultural barriers.

c. *How would ARPA-H need to differ from DARPA and why?*

DARPA is responsible for catalyzing the development of technologies that maintain and advance the capabilities and technical superiority of the **U.S. military**. ARPA-H will achieve **medical breakthroughs** by building new platform technologies to support research that directly affirms, refutes, or otherwise changes current clinical practice. Like DARPA, it would do this using milestone-driven, time-limited contracts as the central mechanism for driving innovation. The main difference is in the mission and focus of the agency. ARPA-H will transform healthcare and medicine as we know it, the same way that DARPA transformed the way we fight wars.

7. *In your testimony, you talked about how the Administration would evaluate ARPA-H.*

    a. *Based on your experience at DARPA, what metrics should be used to assess the progress of ARPA-H?*

DARPA has maximum control over the conduct of its programs. Program Managers meet with performers regularly, sometimes weekly. Performers are often placed on a milestone-based contract where they must meet each milestone to be paid. The program funds are paid out incrementally with demonstrated success. DARPA contracts state that the government may terminate the contract at any time without prior notice and at the government's discretion, meaning failure to perform can result in termination of contract. Because the Administration has decided to place ARPA-H into the NIH structure, ARPA-H independence is at serious risk. The Congress should look carefully at the make-up of its program managers, time for decision making, time for contract implementation, time for execution of Broad Agency Announcements, etc. Since the agency has been placed within a massive bureaucracy, the Congress will want to make sure that it does not succumb to it.

    b. *Additionally, what regulatory agencies or processes are best positioned to evaluate this progress and success?*

It is critical that ARPA-H evaluates the progress and success of each program regularly. At DARPA, the Office Directors meet with each program manager on a quarterly basis and the Agency Director on an annual basis.

Other government agencies are included in reviews. For example, while serving at DARPA, my Revolutionizing Prosthetics program routinely included federal officers from FDA, NIH, VA and NSF at proposal selection and then every quarterly review thereafter. By involving these federal agencies, the program was able to execute more efficiently and deliver the most advanced prosthetic arm/hand to patients in history. In fact, the

prosthetic arm entered clinical trials with the VA collaboration within 2 years, submitted the required new device application for FDA review in 4 years and received full FDA approval by 8 years. We should expect the same efficiency and collaboration of ARPA-H.

The Honorable Tony Cárdenas (D-CA)

1. *ARPA-H is meant to drive transformational innovation in health research and speed application and implementation of health breakthroughs. Emerging human-specific innovations, like organ and tissue chips, organoids, and patient-derived samples, can increase predictiveness of basic biomedical research and nonclinical studies because these methods leverage human biology to produce results that are relevant to humans. Despite the biomedical advancements arising from human-specific innovations, these methods are not prioritized agency-wide. It is also known that animal studies have serious problems in translating to effective health breakthroughs. How might leadership at ARPA-H ensure strategic focus and funding for the development and use of advanced human-specific research approaches to reach the medical breakthroughs we need?*

I will use an example to answer Congressman Cardenas's question. A potential candidate ARPA-H program will be new medical imaging technology.

In 1972, the first CT scanner was made available. In 1977, the MRI scanner was introduced. Since then,45 years later, we have not had another equivalent advancement in medical imaging. Although clinically useful, the current MRI is based on a high strength magnet. That magnet in turn requires a super conducting quantum interference device (SQUID) and thus has high energy requirements and need for specially shielded rooms. This is of course very expensive. Finally, the limit of resolution of 0.8 X 0.8 X 1.6mm for a 1.5T MRI. For reference a cancer cell is 0.001mm.

ARPA-H's objective would be the development of the next-generation medical imaging to have better diagnostic capabilities, be small and lighter, more energy efficient and cost less.

Image resolution and processing could be dramatically improved through a combination of:
1) Application of different physics instead of using superconducting magnets and
2) Advanced signal processing algorithms coupled with AI (artificial intelligence) to increase scan speed and diagnostic accuracy

The ARPA-H process is modeled on DARPA's process.
ARPA-H would follow the DARPA project selection and management process and, in particular as noted above, follow the Heilmeier Catechism. For the advanced imaging diagnostic program, the catechism would be applied as follows:

1) What are you trying to do? Articulate your objectives using absolutely no jargon.

Develop a diagnostic imaging system that detects disease at the earliest stage of development. It will achieve this by having image resolution that is at least 2-3 orders of magnitude superior to MRI, i.e. allow pathology to be detected when it is very early and very small. This new system will be smaller in size, less expensive and more energy efficient than current MRI systems. Finally, it will use technology that is low-risk to patients.

2) How is it done today, and what are the limits of current practice?

MRI technology relies on a very strong magnet to hyperpolarize the hydrogen ions in the patient's body. The image is created by the different orientations the hydrogen ions take when exposed to the magnetic field. However, using a strong magnetic field for medical imaging is inefficient. A very strong magnet is required, which must be supercooled. As a result, MRIs are cumbersome, costly and require tremendous energy.

The most common clinical magnet used in hospitals is 1.5T, generating a magnetic field that is 1.5 times the strength of Earth's gravitational field. Engineers and doctors now use 7T magnets and greater to capture better images. Due to the inherent inefficiency of using magnetic fields, the performance of these large magnets is only marginally better for detecting smaller disease states. The technology has reached its limit.

3) What's new in your approach and why do you think it will be successful?
Apply an entirely different type of physics for medical imaging. Leading options include:

- Quantum Orbital Resonance Spectroscopy (QORS) is a promising physics area to hyperpolarize hydrogen ions. In laboratory studies, QORS has been shown to hyperpolarize hydrogen ions at an efficiency that is 100X better than a magnetic field. It does not require super cooling.
- Ultrasound and Near Infrared (IR) with Compression Imaging combines older techniques with a few novel improvements. Light is scattered when it is transmitted into the body. By coupling this with ultrasound and using time reversed light, the light and sound energies can be optically focused on specific body areas to be studied. Then, new compression imaging techniques can be used. Compression imaging works better when information is sparser and scrambled, making the scattered light of body tissue ideal for measurement. Compression imaging uses these features in a way that reduces the number of required measurements, thus achieving a much greater resolution.

4) Who cares?
According to the Centers for Medicare & Medicaid Services (CMS), the National Health Expenditure grew 3.9% to $3.5 trillion in 2017 and accounted for 17.9% of Gross Domestic Product (GDP). Everyone cares about saving lives and saving money. Beneficiaries of advanced imaging diagnostics would include patients, doctors, insurance companies, pharmaceutical companies and CMS/the U.S. Government, who stands to gain the most.

5) If you're successful, what difference will it make?

An imaging system with greater resolution, that is smaller, lighter and less-expensive than the current MRI will result in: Earlier detection of diseases like cancer and atherosclerosis greatly improving the chances of existing therapies to work; Greater access for small clinics, rural and critical access hospitals and combat zones; Lower operating and patient costs. The cost differential between early and late stage detection of disease supports strengthening our investment in diagnostic programs for early disease detection. Treating advanced versus early-stage breast cancer, for example, is associated with a higher death rate and significant cost increases. In a 2019 analysis, the average costs per patient allowed by the insurance company in the year after diagnosis were $60,637, $82,121, $129,387 and $134,682 for disease stage 0, I/II, III, and IV, respectively. The survival rate for women with stage 0 or stage I breast cancer is close to 100% but drops to just 22% once the cancer metastasizes.

6) What are the risks and payoffs?

The technical risks involved are related to the maturity of the science. A great deal of the physics is understood, but its application to medical imaging is not. The scientific rationale underpinning the various physics approaches will need to be carefully considered. The physicists and technologists working in this space primarily use these techniques for non-medical purposes. Thus, a new community of scholars will need to be formed. From a financial standpoint, this will be disruptive to the current business model of large MRI manufacturers and providers. Finally, there is the opportunity cost if this is not pursued. The benefits are clear. The impact to society is immense.

7) How much will it cost?

Time is the most expensive resource. To mitigate this, sufficient resources must be made available to the performers. A well-managed program will cost about $50-100M over a 4-year period. There must be close supervision by an expert government team working across the technological and medical communities as well. This team will work across government agencies to include DOE, FDA, NIH, NSL, NIST and CMS.

8) How long will it take?

Program execution should be 4 years: Three phases, spanning 4 years, with clear deliverables in each phase. An aggressive timeline with clear milestones and metrics for both success and failure will be required.

9) What are the midterm and final “exams” to check for success?

“Go” and “No-Go” phases can run simultaneously:

Phase 1: Explore and validate potential candidate approaches.

- Duration: 18 months
- Three Technical Goals Need to be Met:

(1) Investigate non-traditional approaches for high resolution local and low resolution global functional imaging, and high resolution structural imaging;
(2) Demonstrate spatiotemporal resolution and imaging depth and FOV compatible with focus area;
(3) Include concepts to stitch together images at different scales.

Phase 2: Develop the most promising technologies.

- Duration: 18 months
- Two Technical Goals Need to be Met:

(1) Mature the leading technologies to overcome the challenges in the focus areas; and

(2) Demonstrate spatiotemporal resolution goals in appropriate preclinical biological models.

Phase 3: Integrate the best technologies to result in a working prototype ready for advanced validation in humans.

- Duration: 12 months
- One Technical Goal is Needed:

(1) Validate the techniques to register low- and high-resolution images.

Program managers must be able to terminate underperforming areas and shift those resources to well performing ones. Regular reviews are necessary and may be as frequent as phone calls every week, short visits every month and semiannual formal reviews. Such an approach requires a small efficient bureaucracy. ARPA-H will be based on the DARPA model of an agency director, office directors and program managers. Authority and responsibility will be hierarchical with the Agency Director having final approval authority. Office managers will have authority over their program managers and programs. The program manager will have the authority to hire/fire performing teams and redirect monies within the program. To stay relevant, the Director, office directors and program managers must serve under term limits, on the order of 3-6 year tenures.