EMPOWERING U.S. VETERANS THROUGH TECHNOLOGY

JOINT HEARING

BEFORE THE

SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

&

SUBCOMMITTEE ON ENERGY

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED FIFTEENTH CONGRESS

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EMPOWERING U.S. VETERANS THROUGH TECHNOLOGY

TUESDAY, MAY 22, 2018

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY AND
SUBCOMMITTEE ON ENERGY,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Subcommittees met, pursuant to call, at 10:00 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Barbara Comstock [Chairwoman of the Subcommittee on Research and Technology] presiding.

LAMAR S. SMITH, Texas
CHAIRMAN

EDDIE BERNICE JOHNSON, Texas
RANKING MEMBER

Congress of the United States
House of Representatives
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
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Empowering U.S. Veterans Through Technology

Tuesday, May 22, 2018
10:00 a.m.
2318 Rayburn House Office Building

Witnesses

Dr. Dimitri Kusnezov, Chief Scientist, National Nuclear Security Administration, U.S. Department of Energy

Mr. Christopher Meek, Founder and Chairman, SoldierStrong

Ms. Martha MacCallum, Advisory Board Member, SoldierStrong

Mr. John Wordin, President and Founder, Project Hero

Dr. Matthew J. Major, Research Health Scientist and Assistant Professor of Physical Medicine and Rehabilitation, Northwestern University

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HEARING CHARTER

May 22, 2018

TO: Members, Subcommittee on Research and Technology, Subcommittee on Energy

FROM: Majority Staff, Committee on Science, Space, and Technology

SUBJECT: Joint Subcommittee Hearing: "Empowering U.S. Veterans Through Technology"

The Subcommittees on Research and Technology and Energy will hold a hearing titled *Empowering U.S. Veterans Through Technology* on Tuesday, May 22, 2018 at 10:00 a.m. in Room 2318 of the Rayburn House Office Building.

Hearing Purpose:

The purpose of the hearing is to examine and highlight cutting-edge federal and private sector technologies designed to help improve U.S. veterans' quality of life. Witnesses will provide an overview of: a unique federal partnership that uses high performance computing capabilities to help improve health care for veterans; a medical robotic exoskeleton device to help injured veterans; a wearable monitoring system to help veterans suffering from post-traumatic stress disorder; and prosthetics and orthotics research to help veterans.

Witness List

- **Dr. Dimitri Kusnezov**, Chief Scientist, National Nuclear Security Administration, U.S. Department of Energy
- **Mr. Christopher Meek**, Founder and Chairman, SoldierStrong
- **Ms. Martha MacCallum**, Advisory Board Member, SoldierStrong
- **Mr. John Wordin**, President and Founder, Project Hero
- **Dr. Matthew J. Major**, Research Health Scientist and Assistant Professor of Physical Medicine and Rehabilitation, Northwestern University

Staff Contact

For questions related to the hearing, please contact Raj Bharwani of the Majority Staff at 202-225-6371.

Chairwoman COMSTOCK. The Committee on Science, Space, and Technology will come to order.

Without objection, the Chair is authorized to declare recesses of the Committee at any time.

Good morning, and welcome to today's hearing titled, "Empowering U.S. Veterans through Technology." I now recognize myself for five minutes for an opening statement.

The impetus for today's hearing goes back a year or so to May 2017, when I first met one of our witnesses, John Wordin, at a Ride 2 Recovery event for veterans in my district in Manassas, Virginia. I heard firsthand from John about the HEROTrak system and the wearable health-monitoring device with software designed to help veterans suffering from post-traumatic stress disorder. I was fascinated by this technology and the research going on with it and its potential to help our veterans.

My district as so many others are home to so many research and technology companies on the forefront of technological innovation, so I am particularly pleased, also with a large veterans' population, to chair this hearing today to profile technologies to help our dedicated veterans who have served our nation. By shining a spotlight on cutting-edge technologies designed to help combat-injured veterans, the Science Committee can help spread the word about the wonderful efforts in which our witnesses are engaged, and their impact on the lives of our brave men and women whose sacrifices deserve our care and attention.

I also look forward to hearing more about the joint Department of Energy and Department of Veterans Affairs collaboration that will leverage DOE's high-performance computing and machine learning capabilities to analyze health records of more than 20 million veterans maintained by the VA. The goal of this partnership is to arm the VA with data it can use to potentially improve health care offered to veterans by developing new treatments and preventive strategies. This win-win enterprise could revolutionize quality of health care for veterans, while simultaneously providing Department of Energy with unique insight and information to support development of next-generation technologies.

We also have representing SoldierStrong Mr. Meek, who will describe the SoldierSuit and his efforts to purchase and donate this transformational robotic exoskeleton device comprised of a number of devices. Amazingly, it can help provide paralyzed veterans the ability to once again stand, walk, and hug a loved one eye-to-eye, a point eloquently emphasized in Ms. MacCallum's testimony. And Ms. MacCallum is probably more familiar being on the other side, being an interviewer of us, is one of our witnesses today, and we really appreciate her being here and her work for veterans.

Now, I mentioned John Wordin, who founded Project Hero ten years ago to help veterans and first responders affected by injuries including traumatic brain injury and PTSD through the programs such as Ride 2 Recovery. While the success of the program and the therapeutic benefits of cycling, which is one of the main activities that he's engaged in with the Ride 2 Recovery have benefited thousands of veterans, but I also appreciate the opportunity to highlight today how the HEROTrak monitoring system can benefit veterans

with PTSD, including how it can help generate more data on best practices to improve the lives of veterans.

And since we did get together with Mr. Wordin with a veterans roundtable in my district yesterday, I can just tell you, and I know this will apply to all of the others testifying today, how excited our veterans' services organizations were to hear about these new technologies and how we can partner with them. For example, we have a lot of equine therapy groups that service veterans in my district, and they understood how when we can get more data here, they can now demonstrate how impactful the equine therapy is for our veterans. They know that instinctively but now we have a way of demonstrating that through data.

And I also welcome Dr. Major, who will describe his very important research on motor control related to veterans and service members' prosthetics and orthotics and the underlying factors of falls.

An added important benefit of today's hearing is that the technologies, research and federal programs we will hear about have promising implications for the population at large.

I thank all our witnesses for joining us today, and for your service and efforts to help improve the lives of our nation's veterans.

[The prepared statement of Chairwoman Comstock follows:]

COMMITTEE ON
SCIENCE, SPACE, & TECHNOLOGY
Lamar Smith, Chairman

For Immediate Release
May 22, 2018

Media Contacts: Thea McDonald, Brandon VerVelde
(202) 225-6371

Statement by Chairwoman Barbara Comstock (R-Va.)

Empowering U.S. Veterans Through Technology

Chairwoman Comstock: The impetus for today's hearing goes back a year ago to May 2017, when I first met one of our witnesses John Wordin at a "Ride 2 Recovery" event for veterans in Manassas, Virginia. I heard first-hand from John about the HERO Trak system and the wearable health-monitoring device with software designed to help veterans suffering from post-traumatic stress disorder (PTSD). I was fascinated by this technology and its potential to help our veterans.

With the 10th District home to many research and technology companies on the forefront of technological innovation, I am especially pleased to chair this hearing today to profile technologies to help our dedicated veterans who have served our nation.

By shining a spotlight on cutting-edge technologies designed to help combat-injured veterans, the Science Committee can help spread the word about the wonderful efforts in which our witnesses are engaged, and their impact on the lives of the brave men and women whose sacrifices deserve our care and attention.

I look forward to hearing more about the joint Department of Energy (DOE) and Department of Veterans Affairs (VA) collaboration that will leverage DOE's high performance computing and machine learning capabilities to analyze health records of more than 20 million veterans maintained by the VA.

The goal of this partnership is to arm the VA with data it can use to potentially improve health care offered to veterans by developing new treatments and preventive strategies.

This win-win enterprise could revolutionize quality of health care for veterans, while simultaneously providing DOE with unique insight and information to support development of next generation technologies.

Representing SoldierStrong, Mr. Meek will describe the SoldierSuit and his efforts to purchase and donate this transformational robotic exoskeleton device comprised of separate devices.

Amazingly, it can help provide paralyzed veterans the ability to once again stand, walk and hug a loved one eye-to-eye—a point eloquently emphasized in Ms. MacCallum's testimony.

John Wordin founded Project Hero ten years ago to help veterans and first responders affected by injuries including traumatic brain injury and PTSD through programs such as Ride 2 Recovery.

While the success of the program and the therapeutic benefits of cycling have benefited thousands of veterans, I appreciate the opportunity to highlight today how the HERO Trak monitoring system can benefit veterans with PTSD, including how it can help generate more data on best practices to improve the lives of veterans.

And I welcome Dr. Major, who will describe his very important research on motor control related to veterans and service members' prosthetics and orthotics and the underlying factors of falls.

An added important benefit of today's hearing is that the technologies, research and federal programs we will hear about have promising implications for the population at large. I thank all our witnesses for joining us today, and for your service and efforts to help improve the lives of our nation's veterans.

###

Chairwoman COMSTOCK. I now recognize the Ranking Member of Research and Technology Subcommittee, the gentleman from Illinois, Mr. Lipinski, for his opening statement.

Mr. LIPINSKI. Thank you, Chairwoman Comstock. Thank you for holding today's hearing. I was just looking up Honor Ride on my iPad here seeing when one in Chicago is, so it's good to have you, Mr. Wordin.

We're only six days away from Memorial Day, and it's the busiest day of the year for me for public events in my district because of the importance my constituents and I place on honoring the men and women who serve in our armed forces.

I'm sure my colleagues on both sides of the aisle in the subcommittees present here this morning agree that supporting technologies that improve the lives of these men and women should be a high priority.

Unfortunately, many face an uphill battle to overcome the physical and mental toll of war once they return home. That's why this hearing is so important.

I want to thank our witnesses for being here to share with us their efforts to provide veterans with the latest technologies to improve their quality of life for our veterans.

Almost 20 million U.S. veterans are living today and just under half are enrolled in the Department of Veterans Affairs' healthcare system. The health records generated from decades of care provide a trove of information that may lead to more accurate diagnosis and treatment of certain conditions and diseases. High-performance computing can help analyze this massive amount of data to make it useful for delivering better healthcare outcomes not only for veterans but also for the general population.

The federal government has made strategic investments over the years to advance data analytics and data science research and development. I look forward to hearing from Dr. Kusnezov about the progress of the Big Data Science Initiative being conducted by the VA and Department of Energy, some of which is taking place in my district at Argonne National Laboratory's Leadership Computing Facility.

I'd also like to hear about the privacy and security measures the agencies are taking to protect our veterans' personal information.

In addition to the diseases and chronic conditions that the VA–DOE collaboration will address, veterans who survive combat may have to adapt to civilian life with limited mobility due to physical injuries sustained in war. A number of federal efforts support research in related areas, including advanced robotic prosthetics and full-body exoskeleton suits. For example, the National Science Foundation funds work examining the interface of brain and machine for mind control of robotic prosthetics, and the National Institute of Standards and Technology has established an international committee to bring together public and private sector stakeholders to define standards for wearable robotics.

While the physical wounds of war can be seen, the mental scars are below the surface. Combat and other traumatizing experiences may result in long-term damage for veterans. Homelessness and suicide may be manifestations of these mental wounds. Eleven to 20 percent of veterans from the most recent combat operations suf-

fer from post-traumatic stress disorder, or PTSD. These figures are similar for Gulf War veterans, and, unfortunately, even greater, 30 percent, for Vietnam veterans.

I look forward to the witnesses' testimony about their efforts to provide physical and mental rehabilitation technologies to our deserving veterans who have already sacrificed so much for our nation. I also look forward to hearing the witnesses' ideas about what more the federal science agencies can be doing to accelerate the development of such technologies.

Thank you, Madam Chair. I look forward to hearing the testimony, and I yield back.

[The prepared statement of Mr. Lipinski follows:]

OPENING STATEMENT
Ranking Member Daniel Lipinski (D-IL)
of the Subcommittee on Research and Technology

House Committee on Science, Space, and Technology
Subcommittee Research and Technology
Subcommittee on Energy
"Empowering U.S. Veterans through Technology"
May 22, 2018

Thank you Chairwoman Comstock for holding today's hearing. Memorial Day is my busiest day of the year for public events in my district because of the importance my constituents and I place on honoring the men and women who serve in our armed forces. I'm sure my colleagues on both sides of the aisle in the subcommittees present this morning agree that supporting technologies that improve the lives of these men and women should be a high priority. Unfortunately many face an uphill battle to overcome the physical and mental toll of war once they return home. That's why this hearing is so important. I want to thank our witnesses for being here to share with us their efforts to provide veterans with the latest technologies to improve their quality of life.

Almost 20 million U.S. veterans are living today and just under half are enrolled in the Department of Veterans Affairs' health care system. The health records generated from decades of care provide a trove of information that may lead to more accurate diagnosis and treatment of certain conditions and diseases. High-performance computing can help analyze this massive amount of data to make it useful for delivering better healthcare outcomes not only for veterans but also for the general population. The federal government has made strategic investments over the years to advance data analytics and data science research and development. I look forward to hearing from Dr. Kusnezov about the progress of the Big Data Science Initiative being conducted by the VA and Department of Energy, some of which is taking place in my district at Argonne National Laboratory's Leadership Computing Facility. I'd also like to hear about the privacy and security measures the agencies are taking to protect our veterans' personal information.

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Thank you Madam Chair. I yield back.

Chairwoman COMSTOCK. Thank you, and I now recognize the Chair of the Committee, Mr. Smith.

Chairman SMITH. Thank you, Chairwoman Comstock, for holding such an interesting and important hearing today.

Today's hearing will highlight some fascinating technologies and efforts that will empower veterans.

The Titan supercomputer at Oak Ridge National Laboratory can process a quadrillion calculations per second. That's a number followed by 15 zeros. Thanks to collaboration between the Department of Energy and the Department of Veterans Affairs, this computer will be used to analyze the health records of 24 million veterans in order to provide improved care. The partnership between the VA and DOE could transform the delivery of healthcare to our veterans as we use complex computer models to learn more about the causes and warning signs of various diseases.

The VA has identified three priority areas of focus for early delivery impacts: suicide prevention, prostate cancer, and cardiovascular disease. By providing DOE with access to a large-scale database, the VA will help the Energy Department develop next-generation algorithms and modeling capability while ultimately providing the VA with data it can use to improve veterans' quality of life.

One of the witnesses today, Mr. John Wordin, is collaborating with a Texas A&M University professor on a wearable device to help veterans suffering from post-traumatic stress disorder, and we also welcome Dr. Farzan Sasangohar, Assistant Professor in the Department of Industrial and Systems Engineering at A&M. Thank you and your team in Texas for your hard work and efforts to support our veterans.

I would also like to thank Mr. Chris Meek and Ms. Martha MacCallum for their respective efforts on behalf of SoldierStrong. In January, SoldierStrong donated a robotic exoskeleton to the Audie Murphy Memorial VA Hospital in San Antonio, which I represent. This donation will help the facility provide state-of-the-art rehabilitative care to veterans.

One of the benefits of hearing from the experts today is that the fruits of their labor are not limited to helping veterans, although they do that so well. They can be applied to people all over the country and the world who suffer from similar ailments or injuries.

In addition to this hearing, the Science Committee approved legislation last November to help veterans overcome obstacles as they reenter the workforce. H.R. 4323, the Supporting Veterans in STEM Careers Act, was introduced by Representative Neal Dunn of Florida, a member of the Science Committee. The bill promotes veterans' involvement in STEM education, computer science, and scientific research and employment. It passed the House in December and awaits action in the Senate.

To me, the subject of the hearing shows yet again how technology can meet the world's challenges, and we look forward to our witnesses' testimony today and to finding out more about how that technology can help not just veterans but, as I said, people around the world.

Thank you, Madam Chair, and yield back.

[The prepared statement of Chairman Smith follows:]

COMMITTEE ON
SCIENCE, SPACE, & TECHNOLOGY
Lamar Smith, Chairman

For Immediate Release
May 22, 2018

Media Contacts: Thea McDonald, Brandon VerVelde
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Statement by Chairman Lamar Smith (R-Texas)

Empowering U.S. Veterans Through Technology

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One of the witnesses today, Mr. John Wordin, is collaborating with a Texas A&M University professor on a wearable device to help veterans suffering from post-traumatic stress disorder. We also welcome Dr. Farzan Sasangohar, assistant professor in the Department of Industrial and Systems Engineering at A&M. Thank you and your team in Texas for your hard work and efforts to support our veterans.

And I would also like to thank Mr. Chris Meek and Ms. Martha MacCallum for their efforts on behalf of SoldierStrong. In January, SoldierStrong donated a robotic exoskeleton to the Audie Murphy Memorial VA Hospital in San Antonio, which I represent. This donation will help the facility provide state-of-the-art rehabilitative care to veterans.

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To me, the subject of this hearing shows yet again how technology can meet the world's challenges.

###

Chairwoman COMSTOCK. And I now recognize the Ranking Member, Ms. Johnson.

Ms. JOHNSON. Thank you very much, Chairwoman Comstock and Ranking Member Lipinski for holding this hearing to learn more about technologies that are being developed to help improve the quality of life for our injured veterans.

This is a topic close to my own heart. Before I ran for political office, I served as the chief psychiatric nurse at the VA Hospital in Dallas where I actually helped to start that service. I saw up close the toll that serving in a combat zone can take on our men and women in uniform. I developed a deep appreciation for human frailty and strength alike, and I carried those lessons forward into my political career.

I regularly meet with veterans in my district in Dallas to learn about the challenges they face reentering civilian life and to discuss what the veterans—what the federal government can be doing better to help ease their transition.

Today there are about 20 million veterans in the United States. Advances in medical response and technology in the battlefield have meant that more veterans are surviving and returning home with traumatic injuries that meant certain death in earlier generations.

The protracted conflicts in Iraq and Afghanistan resulted in many of our veterans serving multiple deployments in combat zones. Even if they survived these deployments without any visible injuries, some almost certainly suffer in other ways. Veterans experience mental health disorders, substance use disorders, post-traumatic stress, and traumatic brain injury at a disproportionate rate compared to their civilian counterparts. Eighteen to 22 American veterans commit suicide daily. Younger veterans are at the highest risk. While an exact count is hard to come by, approximately 40,000 veterans today are homeless. These are statistics that should alarm us all.

Technology will not solve all of these challenges. However, technology can go a long way to aid veterans suffering from both physical injuries and mental health disorders. Continued advancements in prosthetics and exoskeletons will help improve the quality of life for veterans who have lost limbs. More accurate and wearable predictors of PTSD attacks will help veterans keep themselves and their loved ones safe, and better understanding of the range of conditions that occur in the veteran population will help medical professionals and policymakers alike develop more effective interventions.

I look forward to hearing more about the technologies that today's witnesses are working on, and I look forward to a discussion of the role that our science agencies such as the National Science Foundation and the National Institute of Standards and Technology can play in advancing these and other technologies to aid our U.S. veterans. Our veterans deserve nothing less from our nation and our government than our full dedication to helping them repair the wounds of war that they suffered on our behalf.

I thank you and yield back.

[The prepared statement of Ms. Johnson follows:]

OPENING STATEMENT
Ranking Member Eddie Bernice Johnson (D-TX)

House Committee on Science, Space, and Technology
Subcommittee on Research and Technology
Subcommittee on Energy
"Empowering U.S. Veterans through Technology"
May 22, 2018

Thank you Chairwoman Comstock, Ranking Member Lipinski, Chairman Weber, and Ranking Member Veasey for holding this hearing to learn more about technologies that are being developed to help improve the quality of life for our injured veterans. This is a topic close to my own heart. Before I ran for political office, I served as the chief psychiatric nurse at the VA Hospital in Dallas. I saw up close the toll that serving in a combat zone can take on our men and women in uniform. I developed a deep appreciation for human frailty and strength alike, and I carried those lessons forward into my political career. I regularly meet with veterans in my district in Dallas to learn about the challenges they face reentering civilian life and to discuss what the federal government can be doing better to help ease this transition.

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Chairwoman COMSTOCK. Thank you, and I'm now going to introduce our witnesses but before I do, I did want to recognize Steve Jordan of the Northern Virginia Technology Council, who has worked for the Veterans Employment Initiative, which has been an initiative of our technology companies in northern Virginia, which has just done wonderful work with our veterans, and I really appreciate having you here today, Steve, to hear about these great technologies, and both private and public investment, which I know NVTC has already been great with public-private partnerships. So thank you.

Okay. Now, first our first witness today is Dr. Dimitri Kusnezov, Chief Scientist at the National Nuclear Security Administration at the U.S. Department of Energy. Prior to NNSA, he served as Director of the Office of Research and Development for National Security Science and Technology. Dr. Kusnezov earned a bachelor of arts in both physics and pure mathematics from the University of California at Berkeley. He also holds a Master of Science in physics as well as a Ph.D. in theoretical nuclear physics, both from Princeton University.

Our second witness today is Mr. Christopher Meek, Founder and Chairman of SoldierStrong. SoldierStrong helps America's servicemen, -women, and veterans take their next steps forward by identifying and filling gaps in the traditional systems supporting veterans and members of the military. Originally called SoldierSocks, SoldierStrong stems from Mr. Meek's first project organizing donations of socks and other supplies from communities and businesses. Mr. Meek holds a Bachelor of Arts in economics and political science from Syracuse University and a Master of Business Administration and financial management from Pace University in New York City.

Our third witness today is Ms. Martha MacCallum, Advisory Board Member of SoldierStrong. She's here in that capacity today. Of course, we also know her as a Fox News anchor, where she has highlighted numerous military achievements on her show, The Story with Martha MacCallum. Ms. MacCallum's coverage has included the accomplishments and personal stories of the Green Berets, Navy SEALs, and medal winners for extreme bravery in Afghanistan. She earned her bachelor's degree in political science from St. Lawrence University. She also studied at the Circle and the Square Theater School.

Mr. John Wordin, our fourth witness, is President and Founder of Project Hero. His work to improve suicide prevention and help veterans and first responders has earned him national recognition. He began his career as a professional cyclist, participating in three U.S. Olympic Trials and earning a bronze medal in the 1989 U.S. National Championships. Mr. Wordin was also President and Founder of the Fitness Challenge Foundation, which was the genesis of Ride 2 Recovery founded in 2008. Mr. Wordin holds a Bachelor of Science in finance from California State University at Northridge.

And I did want to mention, someone just told me that the Vice President tweeted about the hearing this morning. I know when we first met, you had started your Ride 2 Recovery at the Vice Presi-

dent's house, so I guess he's watching to catch up on this too, so thank you again for joining us today.

Our final witness is Dr. Matthew Major, Research Health Scientist and Assistant Professor of Physical Medicine and Rehabilitation at Northwestern University. Dr. Major's research focuses on improving mobility and function of veterans with neurological and musculoskeletal pathology through rehabilitation technology and therapeutic intervention. He holds Bachelor of Science and Master of Science degrees in mechanical engineering from the University of Illinois at Urbana-Champaign as well as a Ph.D. in biomedical engineering from the University of Salford-Manchester in the United Kingdom.

So I now recognize Dr. Kusnezov for his five minutes to present his testimony.

TESTIMONY OF DR. DIMITRI KUSNEZOV,
CHIEF SCIENTIST,
NATIONAL NUCLEAR SECURITY ADMINISTRATION,
U.S. DEPARTMENT OF ENERGY

Dr. KUSNEZOV. Thank you, Chairman Smith, Ranking Member Johnson, Chairwoman Comstock, Chairman Weber, Ranking Member Lipinski, and Ranking Member Veasey and distinguished Members of the Subcommittee on Research and Technology and the Subcommittee on Energy. I thank you for taking up this important issue and for the opportunity to address the members and share what the Department of Energy in collaboration with the Department of Veterans Affairs is trying to do at the intersection of next-generation artificial intelligence, supercomputing, U.S. innovation, and veterans' health.

At the Department of Energy, driven by where our missions are heading, we work at the forefront of technologies, and today we are embracing artificial intelligence. This coincides with diminishing returns from Moore's Law, where squeezing the most of our 70-year supercomputing paradigm remains important.

This post-Moore's Law era necessitates novel artificial intelligence, or AI, inspired architectures to navigate an increasingly data-driven world. I believe that a cornerstone for progress will be how rapidly we embrace a next generation of AI-enabled predictive supercomputing tools.

Precision medicine data can accelerate this technology change by driving the development with likely the world's most complex data. This brings with us subject-matter experts and unique opportunities to rethink many of our traditional approaches from post-Moore's Law hybrid architectures to uncertainty quantification to computer codes.

Our work with the VA is underpinned by several opportunities for innovation that were captured in the 21st Century Cures Act, the Cancer Moonshot in 2016, and the National Strategic Computing Initiative in 2015. More recently, Secretary Perry's commitment to technology in the service of veterans as well as this Administration's commitment to veterans' issues has allowed the rethinking of traditional paradigms and facilitated novel approaches on how to solve complex problems.

The VA has a unique dataset of medical records, whole genomes and imaging data that is one of the most comprehensive in dimensions of time, scale, and breadth, and in many aspects, this dataset is considered to be the largest and most comprehensive in the world. Both the VA and the Department of Energy are alert to the unique privacy and security sensitivities of the veterans' health data.

Today, our artificial intelligence-driven Big Data Science Initiative includes MVP–CHAMPION and a complementary effort called ACTIVE.

Last year in April, VA and DOE scientists, physicians, and leadership came together to develop technical roadmaps for driving high-performance computing and artificial intelligence while developing solutions to priority issues and caring for our veterans. VA priorities that were identified that could deliver early impacts were patient-specific analysis for suicide prevention, helping doctors make decisions around prostate cancer, and enhanced prediction and diagnosis of cardiovascular disease. Since then, additional areas of interest from polypharmacy to traumatic brain injury have surfaced. The fiscal year 2019 VA budget request includes $27 million to support these initiatives.

We recognize the critical role of the private sector in this effort. Recently the VA and DOE held a meeting with technology startups focused on precision medicine to understand the direction of the technology in the commercial sector. As with the Human Genome Project or the exascale initiative today, partnerships with labs, academia, and the private sector are important. A concerted effort here will lead to innovation tied to design and development of DOE's next-generating supercomputing that will merge big data, artificial intelligence, and high-performance computing; to better healthcare via our strategy for precision medicine through supercomputing and artificial intelligence that could inform when and how to treat our veterans to improve outcomes and control costs; to better science via a cadre of researchers and clinicians who specialize in healthcare with DOE experts in big data, AI, and high-performance computing; and to better government via interagency collaborations bringing to bear the full capabilities and expertise within public and private partnerships.

Thank you, and I look forward to answering your questions.

[The prepared statement of Dr. Kusnezov follows:]

Testimony of Dr. Dimitri Kusnezov

Chief Scientist

Department of Energy/National Nuclear Security Administration

Before the

Subcommittee on Research and Technology & Subcommittee on Energy

Committee on Science, Space and Technology

U.S. House of Representatives

May 22, 2018

Thank you Chairwoman Comstock and Chairman Weber, Ranking Members Lipinski and Veasey, and distinguished Members of the Subcommittees. I thank you for taking up this important issue and for the opportunity to address the Members and share what the Department of Energy (DOE), in collaboration with the Department of Veterans Affairs (VA), is trying to do at the intersection of next-generation supercomputing architectures, U.S. innovation and veterans' health.

Introduction

Driven by complex and often urgent national missions, DOE has honed an ability to attack short- and long-term challenges through big team science and technology efforts. Supported through the technical base of our national laboratories as well as academic, private sector and international partners, no challenge has been too big. In the past three years, several important moments created opportunities for innovation in support of national goals. This includes the National Strategic Computing Initiative (NSCI) in 2015, the Cancer Moonshot in 2016, the 21st Century Cures Act, also in 2016, and Secretary Perry's commitment, as well as this Administration's commitment to Veterans' issues. These have forced the rethinking of traditional paradigms and facilitated novel approaches to how we solve complex problems.

Driven by the aforementioned initiatives' demand for Federal collaboration, in early 2016 a cooperative relationship between DOE and the VA was established. In 2017, this evolved into a Big Data Science Initiative (BDSI) which currently encompasses the Million Veterans Program–Computational Health Analytics for Medical Precision to Improve Outcomes Now (MVP-CHAMPION). As is the case for many of the DOE's missions, next generation computing is making possible things previously thought to be impossible. The willingness to attack complex and significant problems is a hallmark of DOE.

This collaboration addresses both the mission spaces of the VA in treating and improving the lives of veterans, and the expertise and facilities residing at the DOE labs, and through the Economy Act, VA can work with DOE. In the FY19 VA Budget Request, $27 million identified to support this cooperative relationship.

DOE roles in the Life Sciences

It is worth taking a brief moment to recognize DOE's long history of working in the biosciences. Rooted in our history, from the dawn of the nuclear age, was the development of extensive radiation biology programs at the DOE national laboratories. Today we have to manage risk of exposure in everything from the remediation of legacy facilities and waste to planning new construction. Expertise in the biosciences remains core to our responsibilities, however today that is focused on biology to tackle problems from energy production, to determining genomic properties, molecular and regulatory mechanisms, and the resulting functional potential of microbes, plants, and biological communities central to DOE missions.

The Human Genome Initiative, conceived by DOE in 1986, is one of the most transformational efforts in the life sciences. While it built on the existing genome programs at the DOE labs, it was the strength of the labs in adjacent fields that changed a research enterprise from being almost exclusively hypothesis-driven to a data-driven and tool-driven one. It was the resident expertise in these adjacent fields that recognized that advancements in robotics, dye-tagging, computing, lasers and so forth, could be drawn together, converged, to create a viable, yet ambitious, path to sequence the human genome. The initiative was transformed into the Human Genome Project (HGP) in 1990, drawing in the National Institutes of Health (NIH) to help drive the program and engage its research base.

What we know today is that this effort created an entire new economic sector. The cumulative costs through 2003 were likely several billion dollars, as estimated by investments of all the partners, for delivering that first sequence. By the turn of the decade, the global economic impact was already evident, and the benefit to the U.S. economy alone was estimated to be $141 for every $1 spent in the project[1]. Today sequencing is routine and done for many reasons from learning about one's genealogy to forensic sciences or precision medicine. The cost has come down by over a factor of one million, with $100 sequencing on the horizon. We may be at a similar watershed moment in precision medicine and next generation supercomputing, and efforts focused on Veterans' health could be equally or more transformative.

High Performance Computing at Turning Points

The Department, and its predecessors, have tallied over 70 years of leadership in supercomputing and solving big, complex problems. As with the life sciences, our

[1] Tripp, S. and M. Grueber, *Economic Impact of the Human Genome Project: How a $3.8 billion investment drove $796 billion in economic impact, created 310,000 jobs and launched the genomic revolution*, Battelle Memorial Institute, May 2011.

expertise is rooted in the Manhattan Project, and the demands of the mission has stressed the very definitions of computer designs and uses to, not only, meet the nation's needs but redefine the scientific landscape. We have been known for computing at scales that have placed the U.S. in a position of supercomputing pre-eminence for decades. These supercomputers have been and continue to be the cornerstone of our scientific stockpile stewardship program that assures the safety and reliability of the U.S. nuclear weapons arsenal. It is a core competency of DOE and increasingly applied to our missions, from our energy sector responsibilities, to nuclear and cyber security, the grid, fracking to more effectively liberate fossil fuels, and generally as a means to better inform complex decisions or support through scientific discovery.

There are foundational changes coming to this sector that DOE is currently managing through our Exascale programs in the National Nuclear Security Administration and DOE's Office of Science. Exascale is an effort to continue along the high-performance computing trajectory long defined through Moore's Law, but now only after significant performance issues are resolved. These include requiring vast improvements in power efficiency, resilience, computer memory and parallelism. We expect these systems in the next several years, building on the pre-exascale systems currently being delivered at Lawrence Livermore, and Oak Ridge National Laboratories. These systems are important because they provide the needed continuity for our missions to deliver on tools long validated to their problems of interest.

At the same time, there has been notable growth that could be termed a "big data" revolution, leading to many advances, applications and a growing economic sector focused on applications of data science. At DOE we have made contributions to this revolution. What is challenging is the growing scale of data and simulation data.

What underlies effective numerical prediction on our high performance computers (HPCs) is how to deal with big data through uncertainty quantification (UQ). This is our approach of ascribing how much we believe in predictions from the computer and ultimately how we make decisions on critical national security issues. Every day we use UQ for our nuclear weapons missions where certainty in predictions is paramount. Analogous to the hurricane model predictions we see annually with the cones of expected landfall impacts, the discipline developed within DOE is far more complex, but increasingly challenged by the remarkable growth in data capabilities. Imagine having one billion high-resolution photos on your smartphone and asking yourself what kinds of knowledge may be contained in these images. This is the challenge of petabytes of data. Imaging another thousand times more. We are generating experimental data routinely at these scales, and running complex numerical simulations producing equally large amounts of numerical data. Rooted in our scientific method, is the need to state with some measure of precision, the confidence we have in our predictions. Today we have no means to meld the vast amounts of experimental data with the complex simulation data to yield measures of our confidence. Much, if not most, of all of this data is simply not used because it is beyond our ability to fully appreciate or comprehend. We extract what we believe are the most salient features of both experimental and numerical data and use that

comparison as our figures of merit. Our computing paradigm cannot accommodate these needs.

The NSCI launched in July 2015 defined a federal strategy to meet the nation's needs and assigned leadership in exascale to DOE. It identified DOE as a lead agency for high performance computing and defined goals such as adopting "a whole-of-government approach that draws upon the strengths of and seeks cooperation among all executive departments and agencies with significant expertise or equities in HPC while also collaborating with industry and academia." It also required that DOE establish "a viable path forward" for Post-Moore's Law computing. Consequently, over the past several years, we have been investing in Post-Moore's Law technologies, from brain inspired neuromorphic computing, artificial intelligence (AI) and machine learning (ML), to quantum information technologies.

I use AI and ML as the broad umbrella of hardware and software approaches we use today to ask ourselves what we can learn from large and complex data sets without having to specify what we are looking for. It serves as a means to surface often complex or subtle relationships in data, surfacing patterns, and identifying simpler representations of the data.

This last point is especially crucial, and is at the core of why the partnerships in precision medicine and with the VA are so important. The growth of brain inspired computing has been tremendous over the past several years. From Google to Amazon and Walmart, progress is evident almost everywhere. Even the iPhone X has adopted neural inspired technologies into its functionality. This aspect of AI is becoming increasingly prevalent. We began to recognize that AI might be the only means to reconcile the exponential growth in data with our needs to make predictions. Given our longstanding investments in the current computing paradigm in which UQ is a post-hoc addition to the computation, the challenge was finding the means to:

- Force the rethinking of traditional computing paradigms by challenging scientists with qualitatively new classes of prediction and a richness of data;
- Use the qualities of data to change how we think of many of our traditional approaches from computer architectures to UQ to codes.

Precision medicine became the evident accelerant to drive this technology branch of computing, which we would term as the convergence of AI, big data analytics, and our traditional HPC. It has become a means to reconcile the problem of too much complex data, data beyond human abilities to process, and the need to predict.

In December 2016, the 21st Century Cures Act was passed into law. It recognized the important role that DOE should play in precision medicine. Specifically, in TITLE II—DISCOVERY Subtitle B—Advancing Precision Medicine, SEC. 2011. PRECISION MEDICINE INITIATIVE amended Part H of title IV of the Public Health Service Act 19 (42 U.S.C. 289 et seq.) to now include a role for DOE to identify and address the advanced supercomputing and other advanced technology needs for precision

medicine. The convergence of technologies and health sciences will define where precision medicine goes and provides an opportunity for a transformational shift in bioscience. To take this transformational leap, precision medicine is going to drive the technological convergence of traditional supercomputing, smart computing (advanced machine learning and AI), and secure computing, an activity for which DOE is uniquely qualified. This supports the VA FY19 Budget Request and it's intent to engage the relevant services and expertise at the DOE labs.

DOE, VA and MVP-CHAMPION

During 2016, I co-led the Data and Technology Track for the Cancer Moonshot. One of the enduring challenges was that while there is big data out there, it is nearly impossible to access any of it. The partnership with the VA was likely the largest unleashing of medical data to come out of this. While the effort goes well beyond cancer, it originated in the early moments of the Moonshot while the NSCI was fresh and there was an identified incentive to find partnerships to open up data and advance the missions of agencies through HPC.

The partnership between the VA and DOE was engineered to advance the priorities of both agencies. The burgeoning field of data science that includes techniques such as AI has been rapidly transforming our economy at large but is increasingly responsible for advances in biomedicine. These new generation of data science tools grow increasingly more powerful as the breadth, depth, and complexity of the dataset increases. The most striking aspect of this revolution has been the ability of these tools to detect signals that have been stubbornly unapparent to human inspection or otherwise undetected with current data science approaches. One of the challenges of caring for our veterans is the uniqueness of the service-connected conditions derived from serving in the U.S. Armed Forces that are not frequently encountered in civilian medicine. Detecting such types of signals has been a hallmark of AI. The VA has a unique dataset of medical records, whole genomes, and imaging data that is one of the most comprehensive in dimensions of time, scale, and breadth, and in many aspects, this dataset is considered to be the largest and most comprehensive in the world.

The VA-DOE partnership began in early 2016. Following some calls and meetings between DOE, VA and the White House, we pulled together a small team from four DOE labs who were willing to take initial steps to develop this partnership on short notice. Representatives from Lawrence Livermore, Los Alamos, Oak Ridge and Argonne National Labs met with the VA at their Boston, Jamaica Plain site and explored the technical challenges faced by the VA in the ambitious and unparalleled Million Veterans Program. This developed and became MVP-CHAMPION (**M**illion **V**eteran **P**rogram **C**omputational **H**ealth **A**nalytics for **M**edical **P**recision to **I**mprove **O**utcomes **N**ow) in mid-2016. We marked the start with a Statement of Principles co-signed by the Energy Secretary and VA Secretary in June of 2016. Since then, we have added many additional documents to this, from governance charters, the Business Associate Agreements, Institutional Review Board (IRB) agreements, Data Use Agreements, Rules of Behavior and shortly a MOA.

A Big Data Science Initiative (BDSI)

The growth of MVP-CHAMPION from its initial starting point of genomic data coupled to electronic health records into an even more data rich effort is captured in our identification of this as a BDSI. This developed in April of 2017 as we convened to rescope and further define our goals within this initiative. Data transfer activities initiated in November 2016, through a reimbursable IAA for approximately $3.4 million, moving data from the VA to DOE. Today we are envisioning mirror sites, including Argonne and Livermore, where different versions of the data can be configured to tackle distinct classes of problems, including TBI. These sites are significant, since with Oak Ridge, they are pre-exascale and exascale sites where next-generation supercomputer architectures are resident and can be engaged. We are intending to gather VA data, VA provided data, and other sources of data. These include sources such as:

- Million Veterans Program (MVP), currently the world's largest collection of genotypic data;
- VA Corporate Data Warehouse;
- VA disease specific registries;
- National Death Index;
- Center for Medicare and Medicaid Services and other pubic and academic data collections;
- Other VA data types including expanded sets of 'omics' data (e.g., DNA, RNA, proteins, metabolites, microbiome);
- Clinical images (for example radiology, pathology, other medical images);
- Patient-generated data (patient wearable medical devices as an example);
- Social and environmental data; and possibly, data from other federal agencies;
- TRACK-TBI and other relevant or Veteran-centric data sources.

Today we have eight DOE labs engaged. Through DOE's ESNet internet backbone, select VA sites can access the enclave to begin to work with the data. The physical and cyber security as well as privacy impact assessments have been an ongoing part of the stand-up of this effort.

The long term aim of MVP-CHAMPION today is to share DOE and VA resources in a reimbursable, fiscally-responsible manner that enables researchers to share expertise and thereby challenge and change current concepts in large-scale computing and health sciences. To guide the vision, VA and DOE teams need to work together not only on establishing the 'user facility'-like personal health information enclaves but as scientific collaborators. DOE and VA researchers need to understand each other's capabilities, challenges and mission needs in order to identify the high-impact research that will advance DOE and VA missions.

It will be important to also broaden the expertise and capability from the academic and commercial sectors to embrace the best of our country's technology base. There will be opportunities to bring new partners, data, expertise and capability to achieving our goals in aiding our veterans through efforts originating from DOE or VA. Additionally, the

VA/DOE team will need to pull from the best experts and resources across the full DOE national laboratory system and VA enterprise.

Goals

Simply put, the VA and DOE are working in cooperation to drive technology, innovation, and transform health care delivery for veterans bringing together an unparalleled and vast array of healthcare and genomic data with DOE's world class high performance computing (HPC), artificial intelligence and data analytics. By combining expertise, we are already pushing the frontiers of data analytics, next-generation computing, precision health, genomic sciences, and health care delivery. This partnership supports:

- Innovation tied to design and development of DOE's next generation supercomputing that will merge Big Data (BD), AI and High-Performance Computing (HPC) as well as innovation in population science using complex health system and genomic data for knowledge generation.
- Better Healthcare via using supercomputing to inform when and how to treat our veterans to improve outcomes and control cost.
- Better Science via a cadre of researchers and clinicians who specialize in healthcare with the DOE experts in HPC, AI & BD.
- Better Government via interagency collaborations bringing to bear the full capabilities and expertise within, and public private partnerships.

Priority Areas

On April 17-18, 2017, VA and DOE scientists, physicians, and leadership came together to develop technical roadmaps for how HPC can develop solutions to priority issues in caring for our veterans. VA priorities that were identified that could deliver early impacts were: Suicide Prevention, Prostate Cancer and Cardiovascular Disease. Specifically:

- ***Patient specific analysis for Suicide Prevention***: Suicide is the 10th leading cause of death in the US, and is significantly higher in the veteran population, with 20-22 deaths per day. Efforts would improve identification of patients at risk for suicide through new patient-specific algorithms built to securely provide tailored and dynamic suicide risk scores to bring the resources to each veteran at risk. Working closely with VA's Office of Suicide Prevention, the tools would be used to create a clinical decision support system that assists VA clinicians in suicide prevention efforts, and helps to evaluate the effectiveness of various prevention strategies.

- ***Help doctors discern lethal from non-lethal Prostate Cancer:*** Prostate cancer patients may undergo surgeries or other deleterious treatments without knowing if such treatments are actually necessary or effective, since there is no way of determining lethality *a priori*. The collaborative prostate cancer project will build classifiers for prostate cancer that could significantly aid doctors in distinguishing lethal from non-lethal prostate cancers. Reducing unnecessary treatments will

provide an increased quality of life for patients and allow the VA to focus resources where most effective.

- ***Enhanced prediction and diagnosis of Cardio-vascular Disease (CVD):*** CVD is the leading cause of death in US men and women - including veterans - and the cost of care for CVD conditions is high. A collaborative CVD project would build new predictive tools that (1) identify improved sets of risk factors for specific types of CVD and (2) develop methods that will inform individualized drug therapies. The new tools will enhance prediction, diagnosis and management of major CVD subtypes in veterans.

- ***Crosscutting Technology Advances:*** Cutting across the three projects are requirements for next generation AI and BD analytics. These requirements push development of DOE technologies in key areas including large scale data analytics, computer modeling, large scale machine learning and natural language processing. Success in developing these enabling technologies will have large impacts on DOE missions including science, energy, and national security.

Currently, the United States is the only country in the world with the opportunity to partner such a large scale health database with world leading data analytics capabilities. With this partnership, the US can drive cutting edge technology in next generation data analytics and improve quality of life for veterans and all Americans.

Future Partnerships

The FY 2019 VA Budget Request includes $27 million to support MVP-CHAMPION and a new program called ACTIV. This will deepen the collaboration between the VA and DOE and broaden the data and the potential impact. Secretary Perry and the VA Secretary have met many times to discuss these efforts, and we are now working on a broader MOA between our agencies. In May of 2017, Secretary Perry himself as a veteran joined the Million Veterans Program, donating his blood, his DNA and his records to the cause. The MVP dataset contains invaluable information on the connection between genes, environment, behavior and treatment.

As with the Human Genome Project, engagement and support from Congress was paramount to getting things off the ground and started in earnest. With funding from the VA and the expansion of the program these broader activities are potentially transformational for veterans' health and treatment. If we are successful, this will foster US innovation, help define and drive the intersection of artificial intelligence and big data analytics into the very fabric of DOE missions, transforming high performance computing from where it is today. It will define new standards in precision medicine and demonstrate the impact of scale in the application of HPC to medicine. When successful, veterans would be among the first to benefit.

Recently the VA and DOE held a meeting with Silicon Valley startups in computing precision medicine to understand the direction of the technology in the commercial

sector. As with the Human Genome Project, or the Exascale initiative today, partnerships with labs, academia and the private sector are important. We are still in our early stages of moving into this program due to its overall complexity, and we expect that partnerships will be essential.

Closing Remarks

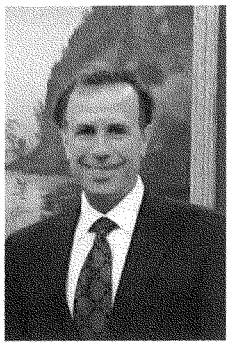
We are starting to incorporate AI into our traditional computer simulations and exploring these new post-Moore design points. This ability to use data science and AI on the fastest supercomputers is a unique capability that depends on the hardware, software, and scientists and engineers at the National Laboratories. The scale of this approach is difficult to achieve any other way. Preliminary testing of an image analysis pipeline for traumatic brain injury magnetic resonance images took only 4 hours on a half-petaflop supercomputer with AI functionality, whereas traditional approaches take days to process an individual's brain scan. It is clear that there are few places where we can do this type of work.

Herein we have seen a natural way for both agencies to advance their missions, and this is informed by the ongoing VA-funded MVP-CHAMPION activities. The challenge of the VA dataset we believe will uniquely stress our computers, codes and people in dimensions that our existing datasets have not. On the other hand, the VA sees the benefit of access to a significant computing ecosystem that has extensive experience of working on complex problems at scale with frontier supercomputers. Additionally, our veteran's data is unique and must be treated with the utmost concern for privacy and other national security considerations. DOE provides a unique safe harbor for the data and applications of tools that is difficult to achieve in the commercial sector and with academic and commercial companies. Yet creating safe and secure opportunities for these stakeholders to work with the data and apply the cutting-edge tools developed in their laboratories and companies is essential for success.

At DOE, we see the challenge of predicting on these datasets as one of the most demanding of our time, therefore we have aligned our National Laboratories to stress the limits of frontier computing for hardware, software and our workforce in novel ways to inform the next generation of hardware acquisition; to inspire the next generation workforce to work on programs that impact the health and welfare of our country in new ways; to leverage the national laboratory system as it was designed to solve pressing problems of national significance that cannot be accomplished by individual investigators; and to innovate at a key moment where we have the unique ability to lead globally.

The United States is the only country in the world, at this moment, with the opportunity to partner a health database of this size with supercomputing resources and expertise. By partnering together, we can push the frontiers of computing and artificial intelligence, keeping DOE and the U.S. a world leader in science and technology. And by working together we can transform health research and healthcare for veterans and all Americans.

Brief Biographical Summary



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B.A. Physics, University of California at Berkeley
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M.S. Physics, Princeton University
Ph.D. Theoretical Nuclear Physics, Princeton University

Dr. Kusnezov currently serves as Chief Scientist at the National Nuclear Security Administration (NNSA) in the U.S. Department of Energy, a position he has held since 2010. He has served in multiple positions within the NNSA including concurrent appointments. This includes the (acting) Chief Information Officer in 2013 and the Director of the Office of Science and Policy from 2010 to 2015. Prior to that, he was the Director of the Office of Research and Development for National Security Science and Technology from 2008 to 2010, (acting) Director of the Office of Defense Science from 2005 to 2006, Director of the Office of Advanced Simulation and Computing from 2003 to 2008, and Program Manager for Physics & Materials Models, ASCI Program from 2001 to 2003. He has also served DOE Secretaries.

Dr. Kusnezov received A.B. degrees in Physics and in Pure Mathematics with highest honors from UC Berkeley in 1982. Following that he spent a year working in a research group at the Institut fur Kernphysik, KFA-Julich, in Julich, Germany. In the fall of 1983 he began his graduate studies at Princeton University, earning his MS in Physics and Ph.D. in Theoretical Nuclear Physics. In 1988 he went on the do post-doctoral research at the Michigan State University National Superconducting Cyclotron Laboratory, later becoming an Instructor in the Physics Department in 1990. In 1991, he joined the faculty of Yale University as an assistant professor in the Physics Department, and then became an associate professor in 1996. He has served as a visiting professor at numerous universities around the world. Dr. Kusnezov has published over 100 articles and edited two books. In late 2001 he left academia to pursue federal service at the National Nuclear Security Administration.

At DOE, he has been responsible for delivering the world's fastest supercomputers including delivering on the DOE 10-year grand challenge for a 100 Teraflop supercomputer in 2005, the novel Blue Gene supercomputer architecture family, and the first petaflop supercomputer, among others. He architected, led and brought to fruition in 2010 the first multiagency governance of the nation's national security S&T base, instituting the Mission Executive Council and a Governance Charter signed at the Cabinet level by DoD, DOE, DHS and ODNI. He developed a Minority Serving Institutions program focusing on STEM based consortia of Historically Black Colleges and Universities with Department of Energy laboratories, with an initial focus on cybersecurity. He created the 'Predictive Capability Framework' in 2006, the integrating approach to the science basis for the US nuclear weapons enterprise and the life-extension programs, underpinned by verification, classes or small and large scale experiments, and uncertainty quantification. It remains a guiding framework for program planning. He architected and launched a strategic partnership on foreign nuclear weapons assessment in 2009 between US Intelligence agencies and the Department of Energy that continues to bring scientific rigor into intelligence fields. He created and launched the Tri-Lab Capacity Computing initiative in 2006, still in place as a transformative measure representing a cost savings to NNSA of 50% in the total cost of ownership of computers and requiring standardization of tools and methods across the NNSA labs – something again not done prior. During 2016, he served as co-lead of the Vice President's Cancer Moonshot effort for Data and Technology, reporting up to the Vice President and the Secretary, delivering on new opportunities that became personally championed by the Vice President. In 2016 he reached out to partner with the Department of Veterans Affairs, creating jointly the MVP-CHAMPION program in mid-2016, and evolving to the Big Data Science Initiative in 2017 with a focus on the intersection of next-generation supercomputing architectures (artificial intelligence, bid data, high performance computing), US innovation and veterans' health.

Chairwoman COMSTOCK. Thank you, and we now recognize Dr. Meek for his testimony.

TESTIMONY OF MR. CHRISTOPHER MEEK,
FOUNDER AND CHAIRMAN,
SOLDIERSTRONG

Mr. MEEK. Chairwoman Comstock and Ranking Member Lipinski of the Subcommittee on Research and Technology, Chairman Weber and Ranking Member Johnson of the Subcommittee on Energy, and members of both Subcommittees, thank you for having me here today.

On September 11, 2001, I was running floor trading operations for Goldman Sachs at Ground Zero in New York City. As I watched the first responders running into the carnage of that day, I resolved to do something to give back to those who serve. I'm still a financial services executive, now at S&P Global, but in the years since that day, my passion project has become SoldierStrong.

SoldierStrong is a 501(c)(3) charitable organization committed to improving the lives of our servicemen, women and veterans. I chair the organization, and accomplish most of its work from a cell phone and an iPad on my daily commute to New York.

SoldierStrong's work started with a request from a forward operating base in Afghanistan to send basic supplies like tube socks and baby wipes for our forward deployed troops. Over the years, we assembled and sent over 75,000 pounds of supplies to 73 units in Iraq and Afghanistan.

As the wars wound down, we contemplated closing down until one of our board members asked whether the troops we had served had everything they needed when they came back home and began life anew as veterans.

In retrospect, one day in particular would bring this question into focus for me. April 27, 2011, was my daughter's fifth birthday. We celebrated, like many families, with cake and ice cream and without a care in the world. Six thousand eight hundred miles away, Army Sergeant Dan Rose was being medevac'd from the battle field to Kandahar. The vehicle he was in had hit an IED, and his injuries would rob him of the ability to walk again. Dan's experience that day was a personal reminder of how much we owe our veterans, and how their sacrifices allow all of us to take for granted the lives we're blessed to live here. Two years after his injury, Dan would become the first recipient of our SoldierSuit, empowering him to walk once again.

Today, SoldierStrong finds the most advanced mobility devices and prosthetics on the market and makes them available to injured veterans who otherwise would not have access to them. The collection of devices we currently fund comprise the SoldierSuit, which covers full-body, upper-body, and lower-body mobility devices. One example is the Ekso Suit, which allows paralyzed veterans to stand and walk again with robotic assistance.

The physical and psychological impacts of being able to get up out of a wheelchair and stand at eye level with the world again are profound. In fact, we are partnering with the Denver VA to conduct a formal study on the mental health impacts of access to this technology.

Another example is the Luke Arm, which is the first and only prosthetic arm that replaces the full range of motion from the shoulder, through the elbow, to the wrist to the fingers and the hand. It is the first arm that works just like the original equipment.

As with many advanced technologies, these devices tend to be extremely expensive, with our average device costing nearly $100,000. Two of our more capable devices cost nearly $200,000 per each.

We've learned over the years that most of these devices were first evolved for frontline servicemen and -women via DARPA.

America's commitment to putting cutting-edge technology on our warfighters is exceptional, is a point of national pride, and should extend, but currently does not, to our veterans who bear the physical consequences of service to our country. We work closely with more than a dozen VA medical centers around the country which have received one or more of our devices. The people of the VA care very deeply about our veterans, but are sometimes held back by arcane regulations that have not kept pace with modern technological advancement. Thanks to SoldierStrong, nearly 25,000 veterans have access to one of these devices. We believe every injured veteran has earned the right to the best technology American ingenuity can provide.

Yet one of the tragedies of the post-9/11 veteran care is that too many veterans must rely on charitable organizations like ours for the access to the medical help they need.

Though it sounds like science fiction, it really hits you that these capabilities are quite real when you see a veteran roll into a room in a wheelchair, but stand for the first time in years and actually walk back out of that same room.

I have with me a short video showing how this technology works. This video was made during one of our device donations to the Richmond VA.

Madam Chair, Mr. Chairman, the video concludes my remarks today. I look forward to answering questions from the Subcommittee. Thank you.

[Video Playback]

[The prepared statement of Mr. Meek follows:]

May 22, 2018

Chairwoman Comstock and Ranking Member Lipinski of the Subcommittee on Research and Technology, Chairman Weber and Ranking Member Lipinski of the subcommittee on Energy, and members of both subcommittees, thank you for having me today.

On September 11, 2001, I was running floor trading operations for Goldman Sachs, at Ground Zero in New York City. As I watched the first responders running into the carnage of that day, I resolved to do something to give back to those who serve.

I'm still a financial services executive, now at S&P. But in the years since that day, my passion project has become SoldierStrong. SoldierStrong is a 501(c)(3) charitable organization committed to improving the lives of our service men and women and veterans. I chair the organization, and accomplish most of its work from a cell phone and an i-pad on my train commute to and from the office each day.

SoldierStrong's work started with a request from a forward operating base in Afghanistan to send basic supplies like tube socks and baby wipes for forward deployed troops. Over the years, we assembled and sent over 75,000 pounds of supplies to 73 deployed units.

As the wars wound down, we contemplated closing down until one of our board members asked whether the troops we had served had everything they needed when they came home and began life anew as veterans.

Our post-war work began with scholarships, including a General Fund scholarship to fill gaps in the post-9/11 GI Bill, and specific scholarships to select institutions. These include the Maxwell School at Syracuse University (the top public service school in the country), the Walsh School at Georgetown University (the top foreign policy school in the country), and a scholarship for veterans who are women in STEM at Old Dominion University.

As important as these scholarships are, we felt there was still a gaping hole in veteran care. So many of our service people survived injuries in Iraq or Afghanistan that would not have been survivable in previous conflicts. Advances in battlefield medicine needed to be met with advances in care for veterans who had sustained such grievous injuries.

In retrospect, one day in particular would bring this question into focus for me. April 27, 2011 was my daughter's fifth birthday. We celebrated like many families, with chocolate

cake and ice cream, and generally without a care in the world. 6800 miles away, Dan Rose was being medevac'd from the battle field to Khandahar. The vehicle he was in had hit an IED, and his injuries would rob him of the ability to walk. Dan's experience that day was a personal reminder of how much we owe our veterans, and how their sacrifices allow all of us to take for granted the lives we're blessed to live here. Two years after his injury, Dan would become the first recipient of our SoldierSuit, empowering him to walk once again.

Today, SoldierStrong finds the most advanced mobility devices and prosthetics on the market and makes them available to injured veterans who otherwise would not have access to them.

The collection of devices we currently fund comprise the "SoldierSuit", which covers full-body, upper-body, and lower-body mobility devices. One example is the Ekso Suit, which allows paralyzed veterans to stand and walk again with robotic assistance. The physical and psychological impacts of being able to get up out of a wheelchair and stand at eye level with the world again are profound. In fact, we are partnering with the Denver VA to complete a formal study on the mental health impacts of access to this technology.

Another example is the Luke Arm, which is the first and only prosthetic arm that replaces the full range of motion from the shoulder, through the elbow, to the wrist, hand, and fingers. It is the first arm that works "just like the original equipment."

We provide a third device, called the Myopro, which is a myoelectric arm brace for veterans who have upper body impairment due to traumatic brain injury.

A fourth device, the Bionx ankle, allows a lower body prosthesis to walk without the characteristic limp caused by most prosthetic legs.

As with many advanced technologies, these devices tend to be very expensive, with our average device costing nearly $100,000 per unit. Two of our more capable devices cost nearly $200,000 per unit.

We've learned over the years that most of the devices we provide were first developed for frontline servicemen and women via DARPA.

America's commitment to putting cutting edge technology on our warfighters is exceptional, is a point of national pride, and should extend (but currently does not extend) to our veterans who bear the physical consequences of service to our country.

We work closely with more than a dozen VA medical centers around the country which have received one or more of our devices. The people of the VA care deeply about our veterans, but are sometimes held back by arcane regulations that have not kept pace with modern technological advancement.

Thanks to SoldierStrong, 25,000 veterans have access to one of these devices. We believe every injured veteran has earned the right to the best technology American ingenuity can provide. Yet one of the tragedies of post 9/11 veteran care is that too many veterans must rely on charitable organizations like ours for access to the medical help they need.

Though it sounds like science fiction, it really hits you that these capabilities are quite real when you see a veteran roll into a room in a wheelchair, but stand for the first time in years and actually walk back out of that same room. I have with me a short video showing how this technology works. This video was made during one of our device donations to the VA.

Madam chair, the video concludes my remarks today. I look forward to answering questions from the subcommittee.

Christopher D. Meek
Chairman & Founder
SoldierStrong

Christopher D. (Chris) Meek is co-founder, Chairman, and CEO of SoldierStrong, a 501c3 charitable organization.

SoldierStrong helps America's service men, women, and veterans take their next steps forward by identifying and filling gaps in the traditional systems supporting veterans and members of our military.

The original name of the organization (SoldierSocks) stems from Meek's first project. Stunned by the fact that our "boots on the ground" in Afghanistan were short of good socks, he sought out donations from communities and businesses, while also creating a nonprofit organization to pursue effective fundraising for the delivery of donated supplies to the troops. Over 75,000 pounds of supplies were delivered to 73 units fighting overseas.

As the wars in Afghanistan and Iraq began to wind down, SoldierStrong broadened its mission to help veterans take next steps on the home front as well.

That includes scholarships to help veterans transition into rewarding civilian careers. SoldierStrong has made monetary commitments to the Maxwell School at Syracuse University, the Walsh School of Foreign Service at Georgetown University, and the Batten School at Old Dominion University to fund scholarships for veterans to continue their education after their military service.

Meek and SoldierStrong have focused on helping veterans who have been paralyzed take literal next steps forward with the SoldierSuit program. Comprised of a variety of devices, most of which originated through DARPA research, paralyzed recipients of the SoldierSuit are able to stand and walk again with the help of a robotic exo-skeletal device provided by SoldierStrong.

In addition to Chris's work as a philanthropist, he is also a Senior Director and Global Relationship Manager at S&P Global, Inc. responsible for some of the firm's largest clients.

Prior to joining S&P Global, Chris was the US Head of Asset Manager ETF Sales at State Street Global Advisors. Chris also spent 16 years at Goldman Sachs as a volatility trader, risk manager, and the last 12 as a Trader on the Institutional ETF Desk where he managed the domestic sector and commodity ETF products. He started his career at MetLife Insurance and has been working in the investment industry since 1992. Chris was listed in CONNECTICUT Magazine's "40 Under 40" as one of the state's up and coming leaders. In October 2011, Chris was awarded the 2011 March of Dimes Franklin Delano Roosevelt Outstanding Corporate Citizen Award.

Chris has a BA in Economics and Political Science from Syracuse University and an MBA in Financial Management from Pace University in New York City. He also holds the FINRA

Series 7, 63 and 55 licenses, as well as the FINRA Supervisory Series 9, 10 and 24 licenses. He is an Adjunct Professor in non-profit management at the Maxwell School of Citizenship and Public Affairs, and is also currently enrolled in Syracuse's EMPA program.

During Philanthropy Week 2014, Meek was awarded the Orange Circle Award by Syracuse University's Chancellor Syverud. Introduced in 2009, the Orange Circle Award recognizes altruistic members of the Syracuse University community who have done extraordinary things in service of other.

Chairwoman COMSTOCK. Thank you.
I now recognize Ms. MacCallum.

**TESTIMONY OF MS. MARTHA MACCALLUM,
ADVISORY BOARD MEMBER,
SOLDIERSTRONG**

Ms. MACCALLUM. Chairman Comstock, Chairman Smith, Ranking Member Lipinski, and Ranking Member Johnson, Members of the Committee, thank you so much for having me here today.

In my work, I am fortunate to speak with generals, military leaders, and Pentagon officials, Navy SEALs and Green Berets as well as many other great men and women who serve or have served our country. In fact, yesterday I spoke with Vice President Pence, who was very interested in the subject matter of our discussion here today, and in particular the work of Mr. Wordin and also the work of SoldierStrong and the U.S. technology that can grow and benefit our veterans and other members of society.

Like most of us, as a citizen, I am enormously grateful to them for their service and humbled by their sacrifice, knowing that as much as I love my country, I could never live up to the measure of their bravery and heroism. Like most of us, I want to show my gratitude to those who put their lives on the line, those who make the sacrifices, who face the danger, who go to the frontlines to protect us, and the freedom that we cherish as Americans.

SoldierStrong was born out of 9/11 out of Chris Meek's desire to prove to our patriots that we are forever thankful, that what we can do as citizens and as a country—through what we do as citizens and as a country is to make sure that we are willing to move forward in combat and that they will now be able to move forward in life. Whatever they lost on the battlefield or in injuries after they've served, we can help them overcome to the greatest of our ability.

9/11 was a day that changed us forever. As a lifelong New York/New Jersey resident, I watched the Towers come down, and with them, the lives of people I knew: the families of those who were lost, 13 fathers and one mother from my hometown. I vowed that day to tell the story of the war on terror and the battles that continue, and to support those who heard the call of President Bush when he said, "the people who knocked these buildings down will hear from all of us soon." The men and women of our armed forces made that message heard loud and clear. Some paid the ultimate price carrying that message to our enemies.

So when Chris Meek came to see me about the organization that he had started with the simple mission of sending basic supplies to our troops to show them we cared and how that mission evolved into opening up a world of possibility for our injured patriots when they came back home, I was in. I joined the Advisory Board in 2014 and have been dedicated to using my voice and the platform that I have through my work to raise awareness and support and to spread the word about the cutting-edge technologies emerging in this field and the life-changing impact they could have for those to whom I owe so much.

The response has been incredible. I believe our viewers and Americans across this country want better for our veterans, better

than a system that leaves gaps and does not allow them to the ingenuity of these new devices.

I will never forget the day that Sergeant Dan Rose came to our studio to demonstrate how his SoldierSuit allowed him to get up from his wheelchair and take the steps that he never dreamed he would be able to take again. The look on his face said it all: will, possibility, and promise.

As Americans we must make sure that we give back but give back in a way that is uniquely American, that relies on this cutting-edge technology, and never taking no for an answer. As JFK once said about the U.S. space mission, "We choose to go to the Moon not because it is easy, but because it is hard."

We live in a time when Ironman is not just a movie. It is moment when technology made in America can rebuild arms with full mobility and allow bodies with severed spinal cords to stand up and walk. Companies like Ekso Bionics, Bionix, Mobius Bionix, and Myomo are leading the way.

But there is still a long way to go, and we will do it, not because it is easy, but because it is hard, and because it is the right thing to do.

Embracing this technology is a winner for the United States, for our military and for those who will benefit from the growth of these industries and the jobs that it creates here at home as well. It makes sense on every level.

Thanks to the work of a very lean and dedicated team, SoldierStrong operates on a budget that puts just 9 to 12 percent towards operating costs. More than 80 percent goes directly to bringing this technology to more than 25,000 veterans at rehab centers and VA facilities across the country so far. SoldierStrong has donated more than $2.5 million in high-technology medical devices that directly help our injured armed forces and $500,000 toward scholarships for those whose way forward is through education that opens doors for their next steps in their lives.

I encourage you to think about how the funding that supports our fighting forces in the field can be extended to support the extraordinary research that's being done with taxpayer funding that will ensure that our injured veterans have access to the scientific advances that come from it.

I thank you very much for your time today and look forward to your questions.

[The prepared statement of Ms. MacCallum follows:]

Testimony of Martha MacCallum
Soldier Strong – Advisory Board Member

Before the United States House of Representatives Committee on Science, Space, and Technology Subcommittee on Research and Technology and Subcommittee on Energy

Tuesday, May 22, 2018

Chairwoman Comstock, Chairman Weber, Ranking Member Lipinski and Ranking Member Veasey, Members of the Committee, thank you for having me here today.

In my work, I am fortunate to speak with Generals, military leaders and Pentagon officials, as well as many of the other great men and women who serve or have served our country.

Like most of us, as a citizen, I am enormously grateful to them for their service and humbled by their sacrifice; knowing that as much as I love my country, I could never live up to the measure of their bravery and heroism. Like most of us, I want to show my gratitude to those who put their lives on the line. Those who make the sacrifices, who face the danger, who go to the front lines to protect us and the freedom we cherish as Americans.

Soldier Strong was born after 9/11, out of Chris Meek's desire to prove to our patriots that we are forever thankful. That what we can do as citizens and as a Country, is make sure that those who were willing to move forward in combat, will now be able to move forward in life. Whatever they lost on the battle field or in injuries after they've served, we can help them overcome to the greatest of our ability.

9/11 was a day that changed us forever. As a lifelong New York/ New Jersey resident, I watched the Towers come down, and with them - the lives of people I knew. The families of 13 fathers and mothers from my hometown. I vowed that day, to tell the story of the War on Terror and the battles that continue to the best of my ability, and to support those who heard the call of President Bush when he said, "[the] people who knocked these buildings down, will hear from all of us soon." The men and women of our armed forces made that message heard loud and clear. Some of them paid the ultimate price carrying that message to our enemies.

When Chris Meek came to see me about the organization he started with the simple mission of sending basic supplies to our troops to show them we cared about them, and how that mission evolved into opening up a world of possibility for our injured patriots when they came back home, I was in. I joined the Advisory Board and have been dedicated to using my voice and the platform I have through my work, to raise awareness and support and to spread the word about the cutting edge technologies emerging in this field and the life changing impact they could have for those to whom I owe so much. The response has been incredible. I believe our viewers and Americans across this country want better for our Veterans. Better than a system that leaves gaps and does not allow them the support they deserve.

I will never forget the day that Dan Rose came to our Studio to demonstrate how his Soldier Suit allowed him to get up from his wheelchair and take the steps he never dreamed he would be able to take again. The look on his face said it all. Will. Possibility. Promise. As Americans we must make sure that we give back to those who gave so much. But give back in a way that is uniquely American, that relies on ingenuity and cutting edge technology, and never taking no for an answer. As JFK once said about the US Space Mission, "we choose to go to the Moon not because it is easy, but because it is hard."

We live in a time when Ironman is not just a movie. It is moment when technology made in America can rebuild arms and allow bodies with severed spinal cords to stand and walk. Companies like Ekso Bionics, Bionix, Mobius Bionix and Myomo are leading the way. But there is still a long way to go. We will do it - not because it is easy, but because it is hard, and because it is the right thing to do.

Embracing this technology is a winner for the U.S, for our military and for those who will benefit from the growth of the industry here as well. It makes sense on every level.

Thanks to the work of a very lean and dedicated team, SoldierStrong operates on a budget that puts just 9-12 percent toward operating costs. 80 percent goes directly to bringing this technology more than 25,000 veterans at rehab centers and VA facilities across the country so far. Soldier Strong has given more than 2.5 million dollars in high tech medical devices that directly help our injured armed forces, when they come home. And $500,000 toward Scholarships for those whose way forward is through education that open doors for their next steps in life.

I encourage you to think about how the funding that supports our fighting forces in the field, can be extended to support the extraordinary research already being done with taxpayer funding and ensure that our injured veterans access to the scientific advances that come from it.

As Veteran Jason Geiger put it, "You can't put a price on walking. You can't put a price on someone's ability to be six feet tall again and stand up and kiss your wife. Or stand up and hug your daughter, or your son. You can't put a price on that."

Thank you for listening and for inviting me here today, on behalf of Soldier Strong.

Martha MacCallum of the Fox News Channel can be seen weekday evenings at 7 pm on "The Story with Martha MacCallum."It is consistently ranked as the #1 Cable News program at 7pm ET.

Martha MacCallum is an integral part of Fox's Election Team – covering 5 cycles of midterm elections and 4 Presidential elections in '04, '08, 2012 and 2016.She has interviewed Presidents Trump and Obama, Vice President Pence, Mitt and Anne Romney, Senator John McCain, Laura Bush and an extensive list of presidential and congressional candidates on the campaign trail. Her wide-ranging interviews include General David Petreaus, Rudy Guiliani and New Jersey Governor Chris Christie.

She has also covered major international and national stories including the terror attack at the Boston Marathon, The Royal Wedding, Hurricane Katrina, and the funeral of Pope John Paul II. In addition to her work with SoldierStrong, Martha has highlighted numerous military achievements on The Story. Her coverage has included the accomplishments and personal stories of The Green Beret, Navy Seals, and has had extensive coverage of medal winners for extreme bravery in Afghanistan. Including interviews with Navy Seal Rob O'Neil and Medal of Honor Dakota Meyer.

At NBC, she covered business news and reported from the floor of the New York Stock Exchange. She was anchor and editor, of CNBC's "Checkpoint," an evening news program focusing on the War on Terror. A frequent contributor to "The News with Brian Williams," and NBC's "Today," show, she was twice the recipient of the Gracie Allen Award, given by the Foundation for American Women in Radio and Television.

Chairwoman COMSTOCK. Thank you, and we will now hear from Mr. Wordin.

TESTIMONY OF MR. JOHN WORDIN,
PRESIDENT AND FOUNDER,
PROJECT HERO

Mr. WORDIN. Good morning, Chairman Comstock, Chairman Weber, and Ranking Members Lipinski and Veasey, and distinguished members of the Energy and Research and Technology Committee. I'd like to introduce Dr. Farzan Sasangohar, Industrial and Systems Engineer at Texas A&M, and we also have with us some veterans from the Project Hero Walter Reed hub program here today.

Project Hero is an organization that brings our nation's veterans and first responders together through sports, activities, and community, helping them overcome challenges associated with their visible and invisible wounds.

Being the catalyst for the adapted sports movement, Project Hero continues to be the industry leader. Dedicated research, including a Georgetown University study, of Project Hero's methods confirms that the work being carried out since its inception is changing and improving the lives of tens of thousands of veterans, first responders, and their families. Remember, the veterans volunteer; the families are drafted.

Our mission is to save lives by providing hope, recovery, and resilience to America's finest. We've had a tremendous impact. Sixty-two percent of our program participants reduce or eliminate their prescription drug use including opioids and antidepressants. PTSD-related stress attacks as measured by the HEROTrak are reduced by 83 perfect. The annual Project Hero participants saves the VA more than $9,000 including prescription drugs and healthcare costs annually.

A soon-to-be-released report reviewed 3,000 suicides to evaluate the cause and effect, and recommend steps to improve care to our veterans and provides data to show why 20 veterans commit suicide each day. What are the risk factors, diagnoses, and family components that are at the root cause of suicide? The review found that the diagnoses most common in all suicides are depression, PTSD, anxiety, and alcohol use disorder with the average suicide having multiple diagnoses. The top risk factors are pain, access to firearms, worsening of health status, relationship problems, hopelessness and decline in physical ability. Most of the suicides were not identified as high risk in their medical record. Of the 20 suicides per day, only three were receiving VA mental health services at the time of their death. The reasons: inconvenience, long wait times, paperwork, transportation, and stigma.

The top recommendation of this report is to come up with an enhanced suicide risk assessment and safety planning capability that addresses the complex care needs of our veterans, utilizing technology, clinician training, and extending more into the community. There is a need for a more systematic assessment tool that can document risk.

The HEROTrak initiative solves this vital need for a technology-based objective solution for suicide prevention and mental health

care. Currently, no PTSD tool exists with remote capabilities to complement ongoing treatment.

The HEROTrak will be a FDA-approved device that will allow continuous monitoring and detection of PTSD triggers using physiological sensors and machine learning algorithms and can measure frequency, severity, and duration of a PTSD episode within two to four seconds. The HEROTrak is a wearable monitor developed by Texas A&M and Dr. Sasangohar and tested exclusively at Project Hero events to learn a user's physiological cues.

Our goal will be to prevent and eliminate suicide in military, veteran, and first responder population, provide the active-duty component with a long-term focus on improving the overall readiness of the force by providing better health and healthcare analytics, and provide support for survivors of sexual trauma and other mental health diagnoses with the care they need. The result will be better therapeutic outcomes at less cost.

Using a combination of heart rate and heart rate variability monitoring, the PTSD alarm will identify triggers. The tool creates a personalized profile that monitors patterns and variability to infer a PTSD episode. If an episode is detected, an alarm vibration goes off with a visual prompt that the user will set up four options of support: self-resilience tools; they can connect to a NoVetAlone peer-to-peer network that they program into the watch themselves, which can including family, friends, or clinicians; it can automatically call the VA crisis hotline or 911. The device pairs with a smartphone and can interface with a website to offer more features including direct connect to peers, military command, or clinicians either by phone or video as desired. The user will also be able to share information with peers in their social network that they wish to create for their own personal support system.

The device can best be utilized when a person first joins the active-duty military to create a baseline and then constantly and consistently collect data on the mental and physical health, report stress events/traumas during their service. The advantage is to maintain objective rather than subjective data and feedback and integrate this information into one's electronic medical records.

This biometric collective data can then provide a medical clinician with the complete mental and physical health picture whenever the participant visits their healthcare provider, thereby understanding whether the prescription drugs they've been using are actually working or whether the care path that they've been put on by their VA or active-duty clinician is actually working. The overall advantage is a more comprehensive, objective measurement of their disability metrics that will lead to increased abilities and a better care continuum.

For the patient, it's a creative way for them to have—for them and their family to understand the environment and surroundings that cause stress episodes in their life. They can look back at the minute, the five minutes, the 30 minutes prior to a PTSD episode and understand what was the trigger.

Up on the screen, we have some of the screenshots of the app that the device pairs with so you can see your data. On here you can see your heart rate, your resting heart rate, your physical activity, the number of stress events, and your—and also your tools.

They will be provided accurate information on the mental and physical state of mind. It will be a patient-centered design that provides a 24/7 support network with medical, resiliency and peer-to-peer support if you have a PTSD episode. It's GPS-enabled so if you become disoriented or pass out, the person who's been alerted to your PTSD episode will be able to know exactly where you are. Peer-to-peer support can provide motivation, feedback, and the support of knowing that you are not alone.

For the clinicians, it provides a complete mental and physical healthcare picture of their patients, a more comprehensive measurement with disability metrics, which lead to increased abilities and provide a more informed care continuum. Up on the screen we have actual data that was driven from one of our testing where you can see how a PTSD episode would look to a clinician. It starts out during sleep, and then you can see the spike in their heart rate that causes the alarm to go off, and it also knows the difference between physical activity and an actual episode.

For the DOD, it creates a baseline that consistently and constantly collects data on their mental and physical health so that they can know the readiness of their troops before going on deployment. It maintains objective data and feedback on the overall readiness of the force, and that information could be integrated into their electronic medical records.

The most important need we have right now as a nation is to prevent more suicides and improve the mental health of those who serve our country. Although the conflicts may be winding down, there is a lifelong commitment we owe to these men and women. The HEROTrak is vital to that commitment to assure that they can see their children grow up in a supportive community.

We all understand the need to reduce suicide and improve mental health for veterans that live and work in each of our districts. There are veterans in your district right now that can be saved by utilizing the HEROTrak.

Thank you very much for your time.

[The prepared statement of Mr. Wordin follows:]

Rep. Comstock (Research & Technology Chairwoman), Rep. Lipinski (R&T Ranking Member), Rep. Weber (Energy Chairman), and Rep. Veasey (Energy Ranking Member): Thank you for the opportunity to present here to the Energy and Research and Technology committees today

Project Hero is an organization that brings our Nation's Veterans and First Responders together through sports, activities, and community - helping them overcome challenges associated with their visible and invisible wounds. Being the catalyst for the adapted sports movement, Project Hero continues to be the industry leader. Dedicated research, including a Georgetown University study, of Project Hero's methods confirms that the work being carried out since its inception is changing and improving the lives of tens of thousands veterans, first responders and their families.

Our Mission is "Saving Lives by providing HOPE, RECOVERY, and RESILIENCE to America's Finest."

Project Hero's Impact:

- 62% of Project Hero participants reduce or eliminate prescription drug use; Opioids by 32% percent; Anti-Depressants by 62%
- PTSD-related stress attacks reduced by up to 83%
- Average annual cost savings for a Project Hero participant for VA mental health care, including prescription drugs, is $9,761/yr.

The Situation

A soon to be released VA report that reviewed 3,000+ suicides to evaluate cause and effect and recommended steps to improve care to our Veterans, provides data, to show why 20 veterans a day commit suicide and the risk factors, diagnoses, and family components that are the root causes of suicide:

The review found that the Diagnoses most common in all suicides are
Depression, PTSD, Anxiety, and Alcohol use disorder
The average suicide had over 2 of the above

The top suicide risk factors are Pain, Access to firearms, Worsening of health status, Relationship problems, Hopelessness, Decline in physical ability

Over half of all suicides had no documented prior attempts noted in their medical record and there was a low prevalence identified as high risk at the time of death.

- 20 veteran suicides per day. Only 3 were receiving VA Mental Health Services. (2018 VA study)

  Reasons:
  1. Inconvenience of care
  - Long wait times
  - Paperwork
  - Transportation

  2. Primary barriers to seeking mental healthcare (self-Imposed)

A. Stigma

The top recommendation of the VA report was to come up with an enhanced suicide risk assessment and safety planning capability that addresses the complex care needs of veterans, utilizing technology and training, extending more into the community. There is a need for a more systematic assessment tool that can document risk.

The HEROTrak initiative solves this vital need for a technology-based objective solution for suicide prevention and mental health care. Currently, no PTSD tool exists with remote capabilities to complement ongoing treatment. Project Hero saw this deficiency and created and launched HEROTrak.

The HEROTrak smart tool will be a FDA approved device that will allow continuous monitoring and detection of PTSD triggers using physiological sensors and machine learning algorithms. It can measure frequency, severity, and duration of a stress event within 2-4 seconds.

The HEROTrak tool is a wearable health monitor developed with Texas A&M University (TAMU) and Dr. Sasangohar and tested exclusively at, Project Hero events to respond to and learn from user's physiological cues.

How much is peace of mind worth to you and your family?

Goals:

- Prevent and eliminate suicide in military/veterans population.
- Provide long term focus on improving the overall readiness of the FORCE by providing better health & healthcare analytics.
- Provide support for survivors of sexual trauma and other mental health diagnoses.

The result will be better therapeutic outcomes at lower cost.

How much is it worth to you and your family to know help is seconds away?

Using a combination of heart rate and heart rate variability monitoring, the PTSD alarm will identify triggers. The tool creates a personalized profile that monitors patterns and variability to infer PTSD triggers. If an episode is predicted, an alarm vibration goes off with a visual to prompt the user to seek help immediately with 4 options: self-resilience tools, connect to NoVetAlone peer to peer network including family, friends, or clinician, call VA crisis hotline, or call 911.

The device will pair with a smart phone and interface with a website to offer more features including direct connect to a peer, military command, or clinician either via phone or video as desired. The user will also be able to share info with peers in a social network they wish to create for their personal #NoVetAlone social support system.

This is just the beginning of combining the performance triad of activity, sleep, and calories burned with mental health to create a tool that can measure ones physical and mental state of mind at any given point.

How much is it worth to know the mental and physical readiness of the force?

The device can best be utilized when a person first joins the military to create a baseline and then constantly and consistently collect data on the mental and physical health, recording any stress events and traumas during their service. The advantage is to maintain objective data and feedback and integrate this information with your electronic medical record. The biometric collective data can provide the medical clinician with a complete mental and physical health picture whenever the participant visits their health care provider and when they transition to the VA with their complete data history. The overall advantage is to have a more comprehensive, objective measurement with disability metrics that will lead to increased abilities and begin the care continuum when appropriate as they enter the VA or commercial healthcare system.

As this integrates into a broader health platform which connects military, VA and commercial together and targets the individual Servicemember or veteran in improving their overall mental, physical, and emotional wellbeing and health readiness.

How much is it worth to you and your family to know that you will not have to fight with the VA over your disability rating?

Advantages

Patient

- Creates a way for a patient and their inner circle (family, friends, caregivers) to understand the environment and surroundings that causes stress episodes in their life and use information to mitigate future events.
- Patient centered design with 24/7 support network (medical, resiliency, peer to peer) for a PTSD episode. All participants in clinical trial favored the tool and expressed strong interest in using one.
- Accurate information on my mental and physical state of mind.
- Peer to Peer support to provide motivation, feedback, and knowing that I am not alone. NoVetAlone
- The device will pair with a smart phone and interface with a website to offer more features including direct connect to a peer, military command, or clinician either via phone or video as desired. As technology improves this device capability will improve.

Clinician

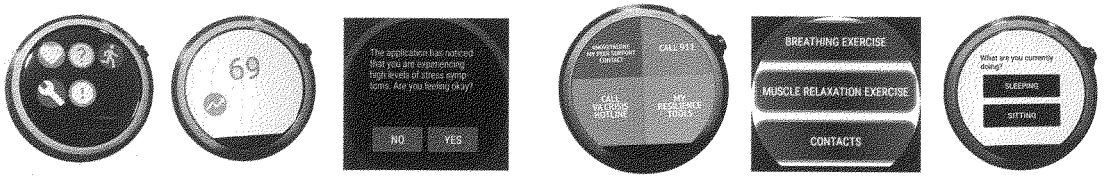
- Complete mental and physical health picture of their patient.
- More comprehensive measurement with disability metrics, which lead to increased abilities and begin more informed care continuum when they enter VA system.

DoD/VA

- Create a baseline and then constantly and consistently collect data on the mental and physical health, recording any incidents, episodes, and traumas during their service. Takes the guess work and stress out of VA disability ratings!!

- Maintain objective data and feedback on overall readiness and integrate this information with the electronic medical record.
- Create a healthier, stronger wellness, recovery and resilience path with active duty/VA medical services support.

HERO TRAK



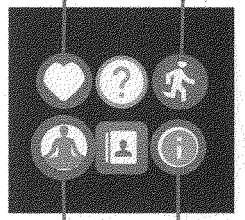
A Mental and Physical Health Biometric & Predictive Analytic System

PROVIDING HOPE ★ RECOVERY ★ RESILIENCE

HEROTrak Application-Home screen

This icon lets you to the ***heart rate check*** menu

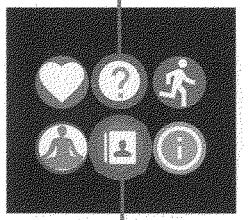
This icon lets you record your ***current activity*** such as resting, sleeping, biking, etc.



This icon leads you to the ***stress relieving activities*** menu

This feature shows you the copyright statement

This icon leads you to the ***questions menu*** on your PTSD application

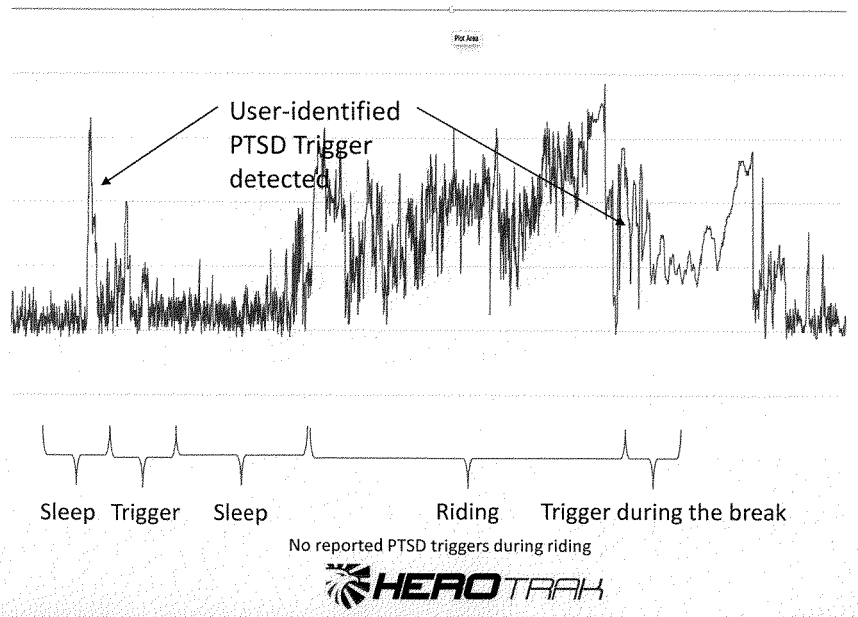


This feature provides you with options to call for help (currently disabled for this study)

HEROTRAK

PROVIDING HOPE ★ RECOVERY ★ RESILIENCE

The device shows promise in identifying activities using heart rate and accelerometer sensor data

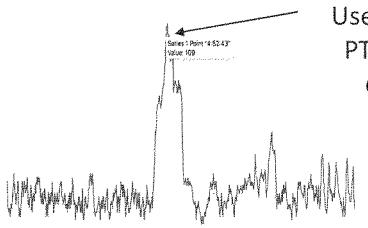


No reported PTSD triggers during riding

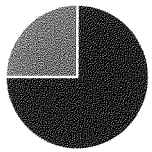
HERO TRAK

PROVIDING HOPE ★ RECOVERY ★ RESILIENCE

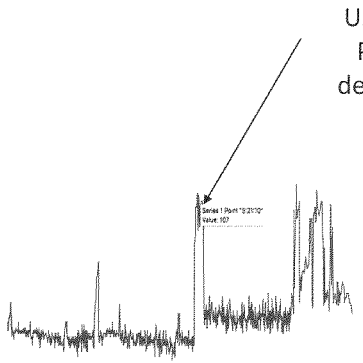
- All 91 instances of self-reported PTSD triggers are identified by the app
- Tool shows promise in identifying PTSD triggers during sleep



Hours of Sleep per night



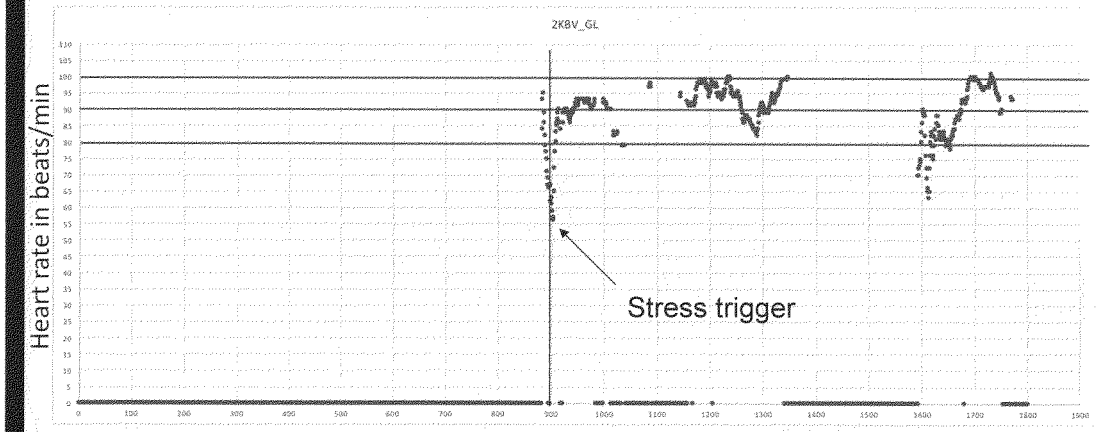
less than 7 hrs of sleep more than 7 hrs of sleep



HERO TRAK

PROVIDING HOPE ★ RECOVERY ★ RESILIENCE

Example of heart rate manifestation of a stress trigger (non-riding)

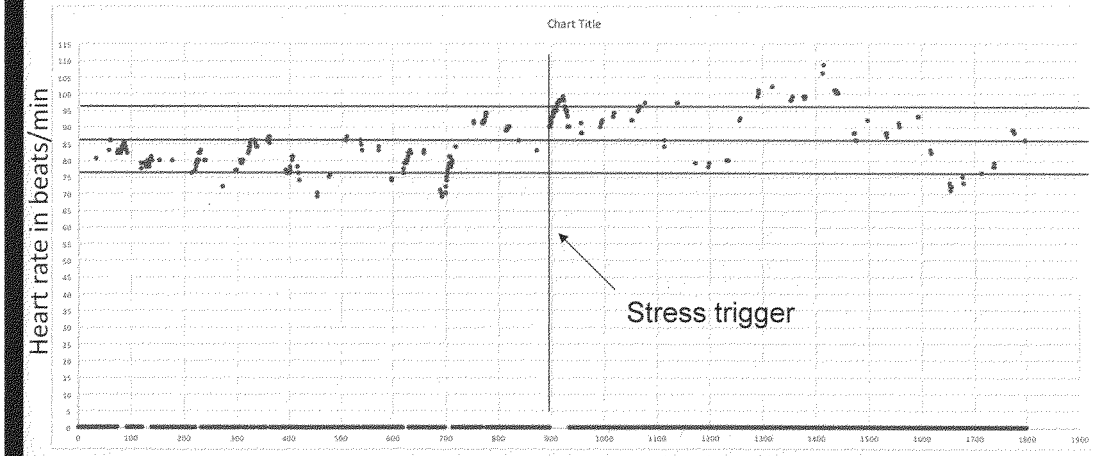


Time in secs (30 min window around the stress trigger)

HERO TRAK

PROVIDING HOPE ★ RECOVERY ★ RESILIENCE

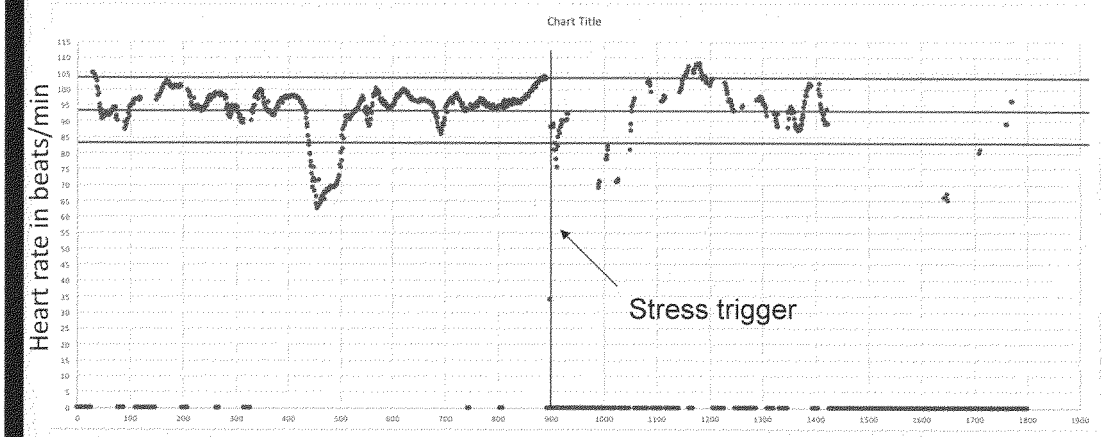
Example of heart rate manifestation of a stress trigger (non-riding)



HERO TRAK

PROVIDING HOPE ★ RECOVERY ★ RESILIENCE

Example of heart rate manifestation of a stress trigger (non-riding)

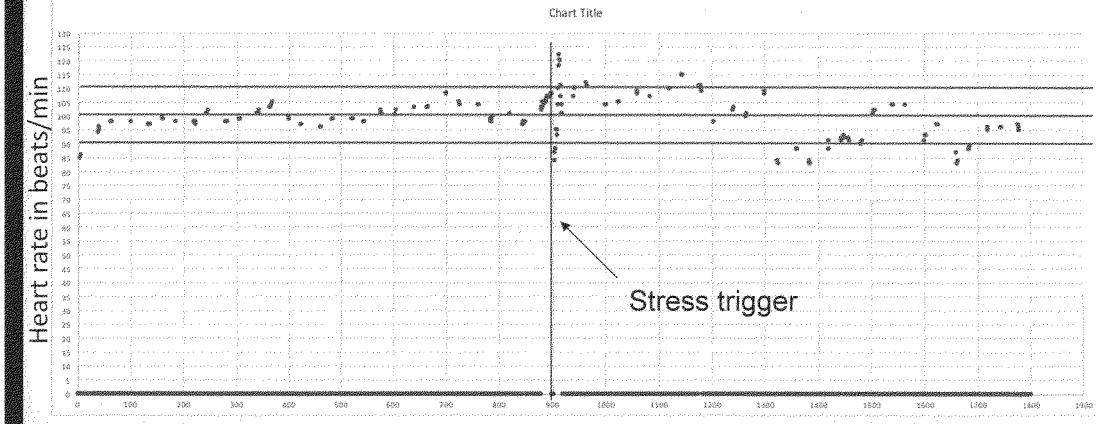


Time in secs (30 min window around the stress trigger)

HERO TRAK

PROVIDING HOPE ★ RECOVERY ★ RESILIENCE

Example of heart rate manifestation of a stress trigger (while riding)



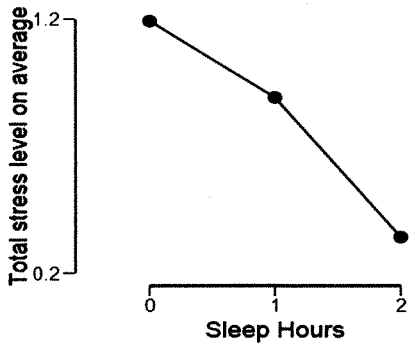
Time in secs (30 min window around the stress trigger)

HERO TRAK

PROVIDING HOPE ★ RECOVERY ★ RESILIENCE

Effect of Sleep Hours on Stress Level

PROJECT HERO
Research Institute of Mental Health
Hope Recovery Resilience

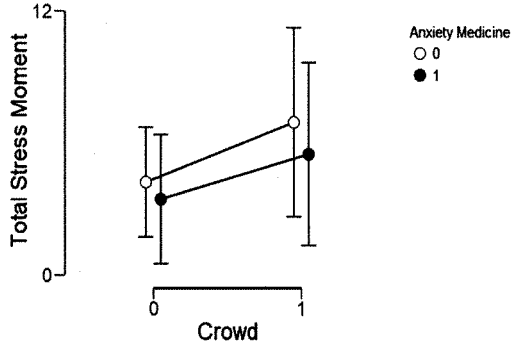


Effect of sleep hours on total stress level including resting and riding days, sleep duration (0 = 0-4 hours, 1= 4-6 hours, 2= more than 6 hours)

Same analysis was conducted to measure the effect of sleep hours on total stress level (sum of stress levels in riding and non-riding days). In general, more sleep was associated with less stress with specially between group 0 (0-4 hours of sleep, M = 1.192, SD = 1.103) and 2 (6-8 hours of sleep, M = 0.342, SD = 0.426)

Effect of Riding Activity on Stress Level

PROJECT HERO
Research Institute of Mental Health
Hope Recovery Resilience



Total stress moments according to crowd trigger (0 = not reported, 1 = reported) and anxiety medication (0 = not used, 1 = used)

The effects of large crowd size and anxiety medication was assessed using a two-way ANOVAs. The interaction between crowds and anxiety medication was not significant ($F(1,65) = 0.36$, $p > 0.1$, $\eta^2 = .001$). Also main effect of large crowds on stress moments was not significant ($F(1, 65) = 1.803$, $p > 0.1$, partial $.\eta^2 = .027$). There was also no significant main effect of anxiety medication on total stress moments ($F(1, 65) = .391$, $p > 0.1$, partial $\eta^2 = .006$)

PROVIDING HOPE ★ RECOVERY ★ RESILIENCE

PROJECT HERO
Research Institute of Mental Health
Hope Recovery Resilience

HERO TRAK

THANK YOU!

PROVIDING HOPE ★ RECOVERY ★ RESILIENCE

JOHN WORDIN BIO

A nationally recognized leader of the movement to improve suicide prevention and help Veterans and First Responders affected by PTSD, TBI, MST and injury, John Wordin is the President and Founder of Project Hero.

A native of Southern California, John was an avid high school and college athlete, earning a scholarship to play football at Cal State Northridge, where he graduated with a B.S. in Finance.

Weighing 260+ lbs. at graduation, he decided to change his lifestyle through exercise, which included cycling, and improving his diet. Within 16 months he was at 185 lbs. and had started a career as a professional cyclist. He participated in 3 US Olympic Trials and earned a Bronze medal in the 1989 US National Championships.

John founded and was president of the Fitness Challenge Foundation, which was the genesis of Ride 2 Recovery, which was founded in 2008, and Project Hero. He was also the director of the Mercury Cycling Team, which became a dominant presence in US professional cycling, winning 535 races from 1998 – 2002, and was named Team of the Year a record 7 consecutive times by the prestigious cycling publication *VeloNews*.

Chairwoman COMSTOCK. And we'll now hear from Dr. Major.

**TESTIMONY OF DR. MATTHEW J. MAJOR,
RESEARCH HEALTH SCIENTIST
AND ASSISTANT PROFESSOR OF
PHYSICAL MEDICINE AND REHABILITATION,
NORTHWESTERN UNIVERSITY**

Dr. MAJOR. Thank you. I'd first like to thank Chairman Barbara Comstock, Ranking Member Daniel Lipinski, Chairman Randy Weber, and Ranking Member Marc Veasey for the invitation to testify. I also want to recognize Chairman Smith and Ranking Member Johnson for joining us this morning.

There exists a large and growing number of veterans with neurological or musculoskeletal pathology who rely on VA rehabilitative care for functional restoration. When medically indicated, an inter disciplinary clinical team delivers custom prostheses or orthoses and implements therapies to train veterans on how to use these devices effectively and ensure long-term rehabilitation success.

I currently conduct studies on the factors that underlie balance and fall risk in persons with upper and lower limb loss. We do not yet fully understand why nearly 50 percent of community living persons with limb loss fall at least once per year, many of whom experience a fall-related injury.

This has considerable implications to veteran qualify of life and VA healthcare costs. My studies aim to identify factors that are useful for fall risk screening and modifiable through balance targeted interventions. Uniquely, these studies utilize technologies for assessing how prosthesis users respond to walking disturbances. Moreover, these platforms can deliver therapies to train users on how to manage disturbances and avoid falls.

I'll provide two examples. In this first example, we use a robot that applies a controlled pull to the pelvis through a system of motors and cables. We're interested in the lessons that can be learned from the unique strategies of the individuals you see here.

In the second example, we see use of an interactive system, which provides both virtual and augmented reality as a means to deliver walking disturbances. This system is used to deliver physical training that requires controlled movements and is combined with cognitive behavioral therapy as part of a holistic treatment.

The remaining projects focus on development and evaluation of prosthetic devices. We're addressing the unique prosthetic needs of women with limb loss and developing prostheses that can accommodate changes in footwear. We're also developing a new method to deliver personalized prosthetic feet and knees based on an individual's body structure and activity level.

Finally, we're designing technology to suspend prostheses from the amputated limb using vacuum suction to improve mobility and limb health.

While prosthetic and orthotic technology is advancing rapidly due to progress in robotics and material science, the most critical aspect to successful rehabilitation are the veterans using these devices. Research and development has granted us the ability to empower veterans with functional impairments but understanding how veterans interact with this technology is crucial. Therefore, we should

support parallel research efforts on development of technology and its clinical application. The success of the rehabilitation process is dependent on clinicians' use of evidence-based practice, which is generated from quality clinical research that considers the holistic needs of patients.

Furthermore, veteran rehabilitation does not end once they are fitted with a device and deployed into the community. Real-world use of this technology provides a window into rehabilitation progress and quality of life. Advances in wearable sensors have improved our ability to collect data on community-based outcomes such as activity level and participation. Research is needed to explore ways in which we can best integrate sensors into devices to monitor user status with minimal interruption to daily living. We also need to examine how these data can guide device designs and rehabilitation strategies to better support independent function.

Overall, veteran rehabilitation research must continue to be interdisciplinary to accelerate its progress, integrating science from engineering and medicine. I argue that we still lack a thorough understanding of the interaction between the human element and rehabilitation technology. More research is needed to better understand: A, how the body responds to different prosthetic and orthotic designs; B, which therapies are most effective; and C, what the long-term outcomes of rehabilitation are on veteran health and quality of life. Filling these gaps will improve personalized rehabilitation interventions and help close the loop between technology and clinical practice.

Ultimately, I believe that technology is driving us towards a future where we can fine-tune rehabilitation interventions with extreme precision, accuracy, and speed. Devices and therapies will be personalized based on individual patient characteristics and smart prostheses and orthoses will collect diagnostic data through onboard sensors. Clinicians will use these data to monitor rehabilitation progress and design interventions while the devices themselves will automatically adjust in real time to meet the demands of daily activity. Combined with advances in telehealth, therapies will be administered remotely without traveling to a clinic and thereby improving access to care.

Real-time monitoring and remote intervention delivery will promote rehabilitation of veterans while permitting continued community engagement. Our end goal is to restore the greatest level of independence, ambulation, and quality of life to veterans which reflects a main priority of the VHA.

I once again thank the Research and Technology Subcommittee and the Energy Subcommittee for this opportunity to testify, and I'm looking forward to the discussion. Thanks.

[The prepared statement of Dr. Major follows:]

Introduction

I would first like to thank Chairwoman Barbara Comstock and Ranking Member Daniel Lipinski of the Research and Technology Subcommittee for the invitation to deliver testimony on this important topic, and thank Chairman Randy Weber and Ranking Member Marc Veasey of the Energy Subcommittee for participating in this joint hearing. My name is Matthew Major. I am a Research Health Scientist at the Jesse Brown VA Medical Center in Chicago, IL, and I also hold a joint appointment as Assistant Professor of Physical Medicine and Rehabilitation at Northwestern University in Chicago. I have been working in these institutions since 2010, but have been performing rehabilitation research for over twelve years. I earned Bachelor of Science and Master of Science Degrees in Mechanical Engineering from the University of Illinois at Urbana-Champaign, and earned a PhD in Biomedical Engineering from the University of Salford, Manchester in the United Kingdom. My expertise is in the application of engineering-based principles to rehabilitation science as it relates to the development and evaluation of prosthetic and orthotic technology. I have been fortunate to benefit from a five-year VA Career Development Award to support early investigators. As a Rehabilitation Scientist and Biomechanist, I am active in both rehabilitation and biomechanics scientific and professional societies. I am also an editorial board member for the journal which serves our clinical profession here in the US, the Journal of Prosthetics and Orthotics.

My testimony will focus on rehabilitation research as it relates to Veterans with neurological or musculoskeletal pathology who are able to benefit from prosthetic and orthotic technology to restore mobility and function.

The Need

One of the highest priorities of the Veterans Health Administration is to provide superior healthcare to Veterans who experience limb loss or neurological trauma, such as stroke. The primary goal of rehabilitation for these Veterans is to restore the greatest level of independence and ambulation. There exists a large and growing number of

Veteran patients with neurological or musculoskeletal pathology who rely on access to the Veterans Health Administration rehabilitative care for functional restoration.

When medically indicated, these Veterans receive prosthetic and orthotic devices as fit by trained clinicians known as prosthetists and orthotists. These devices support the functional needs of these individuals and allow them to realize their full rehabilitation potential. Prostheses serve to replace lost anatomy for restoring walking ability or reaching and grasping, while orthoses serve to restore function of existing anatomy with impaired movement and control. These devices are custom-built for each patient and often assembled from commercial components. Physical therapists provide a critical service by training patients to effectively use these devices, ensuring long-term rehabilitation success. In this context, the responsibility of an interdisciplinary clinical team is to:

1) Best match a prosthetic or orthotic design to the patient user based on their health status, desired outcomes, and rehabilitation potential; and
2) Implement targeted physical and psychological therapies to encourage Veterans to maximize function when using rehabilitation technology.

According to this clinical framework, my research focuses on two primary tracks as a means to improve this clinical process and enhance Veteran care:

1) Development of prosthetic and orthotic rehabilitation technology; and
2) Evaluation of this technology and associated rehabilitation strategies.

The ultimate goal is to enhance quality of life for Veterans using the primary mechanism of supporting their functional needs such that they can have regular and unrestricted participation in leisure, domestic, and work activities. Leisure and domestic activities are of course critical to well-being, but I want to particularly emphasize the importance of gainful employment. The unemployment rate tends to be higher for Veterans than non-Veteran peers and the limitations associated with mobility and functional impairment exacerbates this challenge of return-to-work. My experience has led me to understand that community reintegration is a key component of successful rehabilitation of Veterans, and this objective is a main driver of my research efforts.

The Solutions

My current research is primarily funded by the U.S. Department of Veterans Affairs and the U.S. Department of Defense, and is focused on the rehabilitation of Veterans with limb loss. I will discuss several of these projects relevant to the interdisciplinary clinical framework described previously, and note collaborations that are critical to the success of this research.

My primary project is supported by a Department of Veterans Affairs Career Development Award and involves collaboration with the Edward Hines Jr. VA Hospital and Northwestern University Department of Physical Therapy. The project goal is to better understand the physiological factors that underlie balance issues in Veterans with lower limb loss, such as sensory feedback and motor control. We do not yet fully understand why half of community-living individuals with a single lower limb amputation experience at least one fall per year. For those individuals who do fall, two-thirds fall more than once and forty percent experience a fall-related injury. These issues have considerable implications on quality of life and healthcare costs. The long-term objective of my project is to inform prosthesis designs and physical therapies that enhance balance and reduce the risk of falls and fall-related injuries. In this study we characterize the differences in walking behavior, standing balance, muscle strength, and sensation between non-impaired individuals and persons with limb loss. Through the use of rehabilitation robots, we observe the motor responses of prosthesis users when exposed to a sudden pull to the side. These robots are a unique type of rehabilitation technology that use a system of motors, pulleys, and cables to simulate a gait disturbance by applying controlled pulls to the pelvis while an individual walks on a treadmill. Although useful as a method to assess how persons with limb loss respond to walking disturbances and maintain balance, this same technology can be used to deliver patient-specific, targeted therapies for improving balance. For instance, a Veteran might undergo a series of training sessions with a therapist to explore strategies for managing a disturbance when walking to ultimately promote safe community ambulation.

My second project is supported by the Department of Defense and involves collaboration with the Captain James Lovell Federal Health Care Center and Rosalind Franklin University. This project assesses the efficacy of an integrated therapeutic intervention that combines cognitive behavioral therapy and physical therapy to improve balance confidence in persons with limb loss. Similar to an increased prevalence of falls, individuals with limb loss experience low levels of balance confidence, which is linked to reduced activity levels. Low activity levels and a more sedentary lifestyle have negative consequences on general health and quality of life. The long-term aim of this research is to assess an integrated therapy that can be implemented into the VA and DoD system-of-care for Veterans with lower limb loss to improve balance confidence and increase participation in daily activities. Promotion of community activity and independence increases the likelihood of return-to-work and maintaining employment. In this study, we enroll persons with limb loss in a therapy program that provides multiple sessions of combined cognitive behavioral therapy and step training over several months. The cognitive behavioral therapy is delivered by trained psychologists and aims to increase a person's self-awareness and their confidence in maintaining balance during various forms of daily activity. The physical therapy employs unique rehabilitation technology incorporating virtual and augmented reality environments for individuals to explore strategies to control their body in response to walking disturbances. These disturbances come in the form of targets projected onto a treadmill belt or a virtual environment displayed on a monitor, both of which demand controlled weight shifting and limb movements from the patient. Disturbances are presented in the form of a game to encourage engagement and therapy compliance.

My third project is supported by the Department of Veterans Affairs and investigates the prevalence of falls and the factors related to fall risk in Veterans with upper limb loss. My findings thus far have revealed that similar to individuals with lower limb loss, nearly fifty percent of persons with upper limb loss experience at least one fall in a year. For those individuals who do fall, almost two-thirds fall more than once and a third experience a fall-related injury. We are now investigating the biomechanical and

physiological factors that contribute to increased fall prevalence. We are beginning to understand that use of an upper limb prosthesis can affect an individual's balance based on their perceptions of the device and its inherent characteristics. The ultimate goal of this research is to improve screening procedures that can identify Veterans at risk of falling, and design upper limb prostheses and therapies that enhance balance and safe ambulation.

My fourth project is supported by the Department of Defense and involves collaboration with the Brooke Army Medical Center, VA Puget Sound Health Care System, and the Minneapolis VA Health Care System. This project assesses the prosthetic needs of women Veterans with lower limb loss, a subgroup of Veteran patients that historically has not received as much attention as their male counterparts. Uniquely, women use specific types of footwear and heel heights that interact with prostheses in ways less common than men's footwear. Many commercially-available prostheses are unable to accommodate to the variety of footwear that women might like to wear, thereby restricting their choice of both prosthetic technology and footwear. In this study we are assessing the prosthetic needs and services available to women with lower limb loss, and characterizing the influence that women's footwear has on the function of prostheses. The long-term goal of this project is to make the prosthetic solutions available to women with limb loss more relevant to their needs, and develop clinical guidelines to support their unique clinical care and community integration. A parallel project began recently to develop a new prosthetic foot design that better accommodates to different types of footwear, thereby expanding opportunities for leisure, domestic, and work activities using a single prosthesis.

My fifth project is supported by the Department of Defense, National Institutes of Health, and National Science Foundation and involves collaboration with the Massachusetts Institute of Technology. This project seeks to develop a novel method by which the mechanical function of a prosthesis can be optimized based on a person's individual characteristics. Through clever integration of computer simulation and rapid prosthesis fabrication, we can provide more personalized prosthetic interventions to maximize

rehabilitation outcomes, such as walking dynamics and metabolic economy. Much of my previous research helped define the relationships between prosthesis mechanical function and biomechanical performance to improve evidence-based practice. This research project continues that work by designing prosthetic feet and knees that can be mechanically tuned for each Veteran based on their body characteristics and desired activity levels. The long-term objective of this project is to develop a powerful platform for individualized prosthetic solutions that enhance the quality of clinical care by reducing or eliminating limitations imposed by existing commercial device options. An important aspect of our technology is that it is based purely on a mechanical solution and does not require battery power. This expands application of our technology to situations where durability and reliability are critical, such as rugged terrain for military service members and resource-challenged areas where prosthetic services are limited. The intention is to integrate this technology into the VA and DoD system-of-care, thereby streamlining prosthetic delivery.

Finally, my sixth project was initially supported by the Department of Defense and I am currently seeking further funding from the Department of Veterans Affairs to continue this work. This project involves collaboration with the Minneapolis VA Health Care System, Northwestern University, and industry partners. The objective of this project is to develop new prosthetic technology for maintaining a secure connection between the prosthesis and amputated limb. This concept builds upon existing technology that creates a vacuum between the limb and prosthetic socket to suspend the prosthesis. This vacuum suspension method has demonstrated advantages over other methods by improving limb health and mobility. Our novel technology integrates software and hardware features that expand application of this suspension technique to Veterans of different ages, activity levels, and health status. Having already been awarded one patent, we recently filed a second application on this technology to the U.S. Patent and Trademark Office.

This selection of projects demonstrates how research can address primary aspects of rehabilitative care for Veterans such as the delivery of appropriate prosthetic technology

and therapies that ensure long-term restoration of function and mobility. An important takeaway is that rehabilitation technology can assume the form of prosthetic devices as well as interactive systems for physical therapies.

The Gaps

My research activities describe only a few examples of the various methods by which rehabilitation technology can be applied to improve Veteran quality of life. Prosthetic and orthotic technology is advancing at an impressive pace. We are constantly inventing new devices, methods by which to fit these devices to the Veteran user, and therapies to enhance long-term rehabilitation outcomes. Prosthetic and orthotic devices now include computer control and can learn to work with the user to recognize intent. Prosthetic hands include multiple articulations and degrees of movement for enhanced function. Prosthetic feet can adapt to changes in terrain and have motors for putting a "spring in your step". Techniques for less expensive manufacturing are becoming available and device durability is improving. The application of advances in robotics and material science are responsible for some of this evolution. We have come a long way in what technology is available, but still have a long way to go in understanding how best to use it.

It is important to emphasize that the most critical component to successful rehabilitation and community reintegration is the Veteran using these devices. Research and development grants us the ability to rehabilitate and empower Veterans with functional impairments, but understanding the interaction between Veterans and the devices they depend on is crucial. While prosthetic and orthotic technology will continue to advance with sufficient funding and support, clinicians will always be an integral part to the rehabilitation process. Historically, restoring function through prosthetic and orthotic intervention was largely accomplished via subjective and experience-driven decisions of clinicians as opposed to the application of scientifically rigorous quantitative information in clinical decision-making. This process is evolving as we continue to generate knowledge via clinical studies of how devices and therapies influence rehabilitation outcomes, thereby elevating evidence-based clinical practice. We must also address

Veterans' needs from a holistic perspective, considering both the physical and psychological condition, as this will ultimately yield more accurate personalized interventions. Consequently, we need to support parallel research efforts on technology development and best-practice clinical application of this technology.

As an example, the growing availability and cost-effectiveness of 3D printers has led to the exciting advancement of 3D-printed prosthetic hands as a solution to upper limb loss. However, as with traditional prostheses, these devices need to be fit to the patient by a clinical professional and patients require training to use these prostheses effectively. We see here an opportunity where joint contributions from technology development research and clinical application research can impact rehabilitative care. Part of my responsibility as a rehabilitation scientist is to help determine best-practice guidelines through controlled clinical studies. Clinical studies of prosthetic and orthotic technology inform clinical practice and guide health professionals on how to effectively implement this technology.

Moreover, the process of Veteran rehabilitation does not end once an individual is fit with a device and deployed into the community. Real-world use of this technology and progressive changes in health status provide a window into rehabilitation progress and quality of life. Knowledge of community-based outcomes outside of the laboratory, such as activity level and participation, is challenging to capture. However, advances in wearable technology and the miniaturization of sensors have improved our ability to collect these real-world data in addition to other biosignals such as heart rate. Research is needed to explore ways in which we can integrate sensor technology into prostheses and orthoses to continuously and remotely monitor user status over extended periods of time and with minimal interruption to daily activity. The VA Clinical Prosthetics Services is already making use of activity monitors to quantify device utilization. Accordingly, research must also answer how real-world data can be used in practice by clinicians to optimize device designs or rehabilitation strategies to consistently and fully restore independent function to Veterans while protecting patient privacy.

Overall, Veteran rehabilitation research must continue to be interdisciplinary to accelerate its progress and remain competitive, integrating science from multiple domains including robotics, motor control theory, material science, biomechanics, physical therapy, prosthetics and orthotics, and psychology. We need to encourage interdisciplinary research efforts to advance rehabilitation science for Veterans so that they can achieve their full rehabilitation potential. I argue that we still lack a thorough understanding of the interaction between the human element and rehabilitation technology, whether that is prostheses and orthoses or therapeutic interventions. More progress is needed to better understand how the body acutely and chronically responds to different prosthesis and orthosis designs, which therapies are most effective, and what the long-term outcomes of rehabilitation are on Veteran health, community participation, and quality of life. Filling in the gaps linking the human, rehabilitation technology, and rehabilitation strategies will increase the effectiveness of personalized rehabilitation interventions and help close the loop between technology and clinical practice.

The Horizon

Based on the research activity and gaps I have detailed here, I recently published a proposed framework describing an interdisciplinary approach to maximizing long-term rehabilitation outcomes through shared-decision making. This process that I envisage would be integrated into the VA system-of-care and functions through continuous input from Veterans, engineers, physical and psychological therapists, and prosthetists/orthotists. With this theoretical framework, we will begin integrating physical and cognitive patient-specific health factors to offer fully personalized, holistic-based interventions. We must be mindful that not every Veteran is the same, and neither is their condition. Furthermore, the interventions we apply must not be static, but must constantly adapt to the Veteran user and their changing condition to fully support rehabilitation progress.

While prostheses and orthoses have long been custom-made devices, I believe that technology is driving us towards a future where we can fine tune rehabilitation

interventions with extreme precision, accuracy, and speed. Devices and therapies will be personalized based on individual patient characteristics, and "smart" prostheses and orthoses will collect diagnostic data through on-board sensors. Clinicians will use these data to continuously monitor rehabilitation progress and design interventions, while the devices will automatically adjust in real-time to meet the demands of daily activity. Combined with advances in telehealth, therapies will be administered remotely without travelling to a clinic, thereby improving access to care. Real-time monitoring and remote intervention delivery will promote rehabilitation of Veterans while permitting continued community engagement. Our end goal is to restore the greatest level of independence, ambulation, and quality of life to Veterans with neurological and musculoskeletal pathology, which reflects a main priority of the VHA and fuels my passion for this work.

In conclusion, I would like to summarize this testimony with four key points:

1. Prosthetic and orthotic technology to support the rehabilitation of Veterans with functional impairments will continue to rapidly advance with further improvements in robotics and material science.
2. As technology advances, we must continue to explore the clinical application of these devices and holistic therapeutic interventions to elevate the quality of evidence-based practice.
3. We have a unique opportunity to develop interdisciplinary approaches to rehabilitation involving shared decisions of Veterans, clinicians and engineers.
4. Parallel research on technology development and rehabilitation strategies is necessary to fully address the functional needs of Veterans and design personalized interventions to maximize long-term rehabilitation outcomes.

I once again thank the Research and Technology and Energy Subcommittees for this opportunity to testify and highlight research that is being supported by the VA and DoD to empower U.S. Veterans through rehabilitation technology.

Matthew J. Major, PhD

Dr. Matthew J. Major, PhD, is a Research Health Scientist at the Jesse Brown VA Medical Center in Chicago, IL, and an Assistant Professor of Physical Medicine and Rehabilitation at Northwestern University in Chicago. He has been working in these institutions since 2010, but performing rehabilitation science research for over twelve years. He earned Bachelor of Science and Master of Science Degrees in Mechanical Engineering from the University of Illinois at Urbana-Champaign, and earned a PhD in Biomedical Engineering from the University of Salford, Manchester in the United Kingdom. Prior to completing a postdoctoral fellowship at Northwestern University in Rehabilitation Engineering, he conducted research as a Whitaker International Fellow in England and a National Science Foundation Graduate Scholar in Japan.

Dr. Major's research is currently funded through a U.S. Department of Veterans Affairs Career Development Award and several grants from the U.S. Department of Defense, National Science Foundation, and National Institutes of Health. His research focuses on improving mobility and function of Veterans with neurological and musculoskeletal pathology through rehabilitation technology and therapeutic intervention. He also instructs for the Master's in Prosthetics and Orthotics clinical education program at Northwestern University. He is a member of the American Academy of Orthotists and Prosthetists and the American Society of Biomechanics, and regularly presents his research findings at national and international scientific and clinical conferences. He serves as a manuscript reviewer for 28 scientific publications and conferences, and is a grant proposal reviewer for the U.S. Department of Veterans Affairs and National Institutes of Health. Dr. Major is an editorial board member of the Journal of Prosthetics and Orthotics, and a member of the Research Committee for the Orthotic and Prosthetic Education and Research Foundation.

Chairwoman COMSTOCK. Great. Thank you all so much. What inspiring work you're all doing, and the innovation is really exciting.

So I kind of picking up from when we had our veterans' roundtable yesterday, one of the things was how we can integrate these services. First of all, Mr. Wordin, and then I wanted to kind of ask everyone this question, what three things can we do, and maybe give us some action items for each of you to get what you're working on advanced and out to more of our veterans.

Mr. WORDIN. Well, the first thing is easy. It's funding. I mean, the technology groups I think in all the speeches talked about funding and the need for more technology for technology because it has such a—it'll have such a large impact. I mean, we talked yesterday in the forum about how, for example, people are trying to justify or understand how valuable equine therapy is. Well, if every participant was wearing a HEROTrak device, you'd be able to tell immediately the overall mental and physical impact that that therapy was having on that particular person, and so then you can make better informed decisions as both a patient, as a clinician, as a Congress on where to appropriate and prioritize that funding.

Technology will continue to evolve, and I would say that's the second issue is as technology evolves, particularly our device will become even more powerful. As phones become more powerful, as the wearable technology becomes more powerful, battery life improves, the reliability of the algorithm improves, the device will become even more efficient and even more valuable.

And then the third thing is just being able to work within the VA system, which I think is the biggest source of frustration for veterans. In that study that was quoted where they talked about inconvenience, long wait times, paperwork, transportation and stigma, you know, the VA has its challenges and—but also the way that VA treats nonprofits, outside groups and how can we interact with them is very, very complicated. I mean, we're lucky. We're one of the few—we were the first with Secretary Shulkin to be an authorized mental health and suicide prevention program of the VA, but even with that official designation, we still have a hard time working with individual VA Medical Centers. And so how can we fix—I don't even know if fix is the right word but how can we make it so that while it's a lot easier to deal with active-duty component with DOD, it's very, very complicated with the VA, and it's still the federal government. There's still supposed to be one rulebook.

Chairwoman COMSTOCK. And Ms. MacCallum and Mr. Meek, what has been your experience in working with the VA and how can we help advance—and obviously I think we all agree getting more funding directed to this but how can we integrate better?

Ms. MACCALLUM. Just looking at the VA request for 2019, $198 billion, $727 million of that request is for medical prosthetic research. So funding is clearly one of the big issues. And when I think about SoldierStrong, there's 170 VA Medical Centers in the country—and this goes to what Mr. Wordin was saying—we have devices in 12 of them so far. So the issue of scale and scaling up so that these devices are more available to veterans across the country is clearly one of the big goals here, and then, you know, in terms of what I do, I just think communication and helping people to understand across the country what our veterans go through

when they get home. I mean, I think that's a message that we need to continue to spread and that's something that, you know, I would like to see more news organizations spend more time on, and that's an effort that I would make.

You know, I look at one of the quotes from one of the veterans that we've spoken to. He said, you know, you feel like a burden and you avoid social situations, so that alone is such a hampering factor to moving forward. So we want to find a way to, you know, help veterans feel, especially when they're using these devices, that they're not in the way, that they're normal, that they're part of society, and I think raising awareness through great communication is something that will go a long way to that.

Chairwoman COMSTOCK. Thank you.

Mr. MEEK. I think I'd agree with Mr. Wordin. I think the two things that you can do are first to pass legislation making this technology available to all veterans, and more importantly is funding the appropriations. It's one thing to pass a bill, but if you can't pay for it, it's not going to do anybody any good.

You know, there's several great organizations up here all doing some great things, but at the end of the day, we're all fighting for the same private sector, private donor dollar. There's only so much of that out there, and so getting help from people like yourself and this Committee will really help transform the lives of those veterans who need it.

Chairwoman COMSTOCK. And I think one of the things I think you've all demonstrated in testifying, when these devices and these things are made available, it's lowering PTSD, it improves lives, and we actually do have long-term savings here as well as obviously improved quality of life and the right thing to do, so there is a win-win result from this.

Mr. MEEK. Well, and as you mentioned before, a lot of these devices were originally funded through DARPA, and what we're finding now is that there's no DARPA for veterans when they come back home, and so that's why I think organizations like ours are trying to backfill here is to step up and fill that void.

Chairwoman COMSTOCK. Thank you very much. I see my time is up.

I now recognize Mr. Lipinski.

Mr. LIPINSKI. Thank you, and I want to thank all the witnesses for their testimony. A lot of interesting work in different areas to help our veterans with technology.

I wanted to start with Dr. Major. You mentioned the potential of smart prostheses that can incorporate onboard sensors and real-world data to improve rehabilitation progress and design interventions. What are the current challenges that the field faces in achieving the goal of smart prostheses and what federal resources are needed or could be leveraged to reach this target?

Dr. MAJOR. Thank you for the question. Yeah, I think in terms of the challenges that we face this early, it's difficult actually to find ways to effectively integrate these sensors. I mean, there are a lot of sensors that are available. Miniaturization of these sensors actually helps provide the ability to be able to include them in such devices like these, but again, I think what we're lacking is once the sensors are actually included is trying to essentially use that map-

ping between the data that is being derived from real-world use and what it essentially means and how we should direct that to how these devices either interact with the patients, help the user, learn from the user, and improve their mobility essentially. So I think there's still some gaps that are missing in terms of research. A lot of this is essentially basic research in the sense that again once the data is available, how do you effectively use it, and I think we need to make certain that research is being directed in a way that we can answer some of those questions to fill those gaps. Because, again, the sensor technology has improved dramatically and it's rapidly advancing because they're getting smaller and smaller, and our ability to include them in devices such as prostheses and orthoses at this point is much improved. I don't necessarily think that's one of the bigger challenges.

Powering those devices, powering those sensors, that is a challenge of course because they do require onboard battery power as well, and obviously in advances in battery power and miniaturizing that technology will obviously help in this case, but again, research does need to be directed to answer those questions on how we use the data effectively, how we can do that, collect the data, how clinicians can then use the data but at the same time also protecting the privacy of the patient because once you have all this data that is streaming in, one of the important things obviously is to make sure that patient privacy is being considered in that case.

Mr. LIPINSKI. Are we training or have we trained the next generation of scientists to do this work that's needed that reaches across a lot of different areas? Do you think we're doing an adequate job of that? Do we need to do more and focus—well, do we need to do more there?

Dr. MAJOR. I'd be hesitant to speak more broadly but in my experience, I think we are. I think one of the benefits of this type of research is that it is interdisciplinary and we need to make sure that it continues to be so, right, because again, it is this combination of engineering and medicine but we need to start of course integrating other disciplines as well, whether that's material science, robotics, psychology, whatever it might be, but we need to make sure that we're still promoting that type of integrative, interdisciplinary research to make sure that we're staying competitive and we're advancing the process of this particular science.

So I think we are doing an excellent job. Of course we can always do better, and as long as we continue on this track, I think this particular research will remain competitive and we'll be able to take the steps that we need to elevate this type of technology.

Mr. LIPINSKI. Moving on, it's great to see, Mr. Wordin, the work that you're doing with HEROTrak, and we still—veteran suicide data is inconclusive. We're still trying to understand this. What does your—you know, what does HEROTrak really provide in that direction and what else more do you think can be done to leverage commercial technologies in order to do this?

Mr. WORDIN. Well, this report that's about to come out is pretty clear on what the root causes and diagnoses of suicide are, and when you get into depression, anxiety, hopelessness, you know, those are all factors, and what we found in our research so far in our testing of the HEROTrak is that veterans feel like they have

a support system with them 24/7 right on their wrist because it can connect to a loved one, a clinician, a family member or a peer so that if they have an episode, they're able to get help immediately and it's something that they direct so they're in control. And so the feedback that we've been getting from our focus groups has been really remarkable in the acceptance of being able to wear basically a technology monitoring device that understands what's going on with you mentally and physically. And so that power helps alleviate that hopelessness. So if you are feeling depressed, you know, hey, if I have an episode, you know, it automatically will text-message my buddy from Iraq or my wife or my girlfriend or my father or whatever, you know, you particularly program in, and that ability really creates that sliver of hope that's the difference between suicide and not suicide.

Mr. LIPINSKI. Thank you very much. My time is up. A lot of things to talk about here but I thank all of you for the work that you're doing.

Chairwoman COMSTOCK. And I now recognize Mr. Weber.

Mr. WEBER. Thank you, Chairwoman.

Dr. Kusnezov, in your prepared testimony, you talked about how the DOE national labs have a history of research collaboration and the ability to confront short- and long-term complex science challenges. Hold that thought in mind for just one second.

Ms. MacCallum, you said you talked to a vet who felt a stigma when trying to interact with——

Ms. MACCALLUM. Going out and socializing and being in a wheelchair and trying to get around people and feeling that he was, quote, in the way.

Mr. WEBER. Perfect. Mr. Wordin, you listed all of the causes of suicide, and do you have that list available for us where we can get that later? Anxiety, depression. Was stigma one of those causes?

Mr. WORDIN. No, but stigma is one of the reasons why they don't receive VA medical services.

Mr. WEBER. Okay. Thank you.

Now, Dr. Kusnezov, back to you. The DOE has a history of working with some of those other agencies where you said earlier, I think quite frankly, and Mr. Wordin, you said that the VA has trouble working with outside groups. Well, I would proffer up the point that the Department of Energy does not, and they do a lot of good research, so I'm coming back to you, Doctor. I've got a point to this dialog here. How does the Department and the national labs benefit from performing data analytics and computational research on behalf of the VA, and then how do we meld this problem together? We'll come back to you all later. Go ahead.

Dr. KUSNEZOV. Thank you. That's the right question to ask. For us, the data with its unique complexity that comes with subject-matter experts, that is curated by experts brings with us a team of specialists that allows us to attack the artificial intelligence and technology challenge with our experts. And so the meeting, the intersection happens at that place where we look at the priority questions that the Veterans Administration to surface. We bring together the technology specialists, the hardware, the software, the engineers and ask how do we answer those questions.

Mr. WEBER. And many times, those are outside industry and groups. Keep going.

Dr. KUSNEZOV. Yes. So the nexus is the two agencies coming together. We draw from the breadth of the laboratories. We engage the private sector and academia as needed. We bring in as many people as we can because we recognize it's going to be an all-of-the-above type of activity to answer these priority areas the Veterans Administration has defined.

Mr. WEBER. So I mean, actually, that's a perfect marriage, if you will, in that we have that ability and we're able to do that and thereby do away with the stigma, do away with the non-ability to work with outside groups and to make this as seamless as possible. I'm still going to come back to you for one more.

These research partnerships have the potential to accelerate scientific breakthroughs and healthcare delivery systems and biosciences. Should the Department replicate this model in other fields of research, and what steps can we as Congress take to facilitate that?

Dr. KUSNEZOV. So I think the answer is yes in terms of replication. Our focal point right now has been on the veterans' health data and on the precision medicine dataset because of its unique complexities because it comes with annotations, with handwritten notes, with data streams and imagery and collections of multimodal data that talks to a situation in unique ways that was going to test how we develop predictive technologies, artificially intelligent-based computing. When we start to get our head around what those hardware and software technologies are, these are ones we want to apply to other areas but we find that the highest leverage opportunity for us is around this dataset because it draws in so many other partners who want to come, who want to participate, and it's a force multiplier for our activities.

Mr. WEBER. Well, that brings up another question, and so do you see any problems with the DOE and the VA working together?

Dr. KUSNEZOV. No, not at all. In the beginning of April, Secretary Perry and Acting Secretary Wilkie did sign a new MOA to work together that we have started to implement now. It identifies more data than we already have resident that we plan to aggregate so we have a very nice path forward.

Mr. WEBER. What process would you use to report back to Congress, in other words, to say, this is working, we're making huge steps in the right direction? How do we get that from you?

Dr. KUSNEZOV. I think at your discretion, coming to you with the VA side by side would be an effective means to do that.

Mr. WEBER. Okay. Thank you, Madam Chair. I'm going to yield back at this time.

Chairwoman COMSTOCK. Thank you, and I now recognize Mr. Veasey for 5 minutes.

Mr. VEASEY. Thank you, Madam Chair.

I wanted to ask a couple questions on data privacy and cybersecurity. Dr. Kusnezov, the information collected for the Big Data Science Initiative is obviously very sensitive information. Almost 600,000 veterans have voluntarily given DNA and other samples that can be used, and what I want to know is, how is the VA and

the DOE working together to implement federal requirements for cybersecurity?

Dr. KUSNEZOV. Thank you very much. I would add to your list of the veterans who have signed up the Secretary of Energy. Secretary Perry also joined personally in May of 2017 donating his DNA and his medical records to the set so security of course is important. The personal health information enclave, the initial one we launched at Oak Ridge National Laboratory is what's considered moderate with enhanced controls under the FIPS 199 standard that meets both HIPAA and HITECH Act requirements. So we've set up an enclave consistent with the protection standards, but in addition, through our CIO Office, through our cybersecurity specialists and privacy specialists, we do external reviews of the enclave. We also have engaged the VA counterparts in the information security offices for their assessment of how we protect the data.

In addition, we were very sensitive to appropriate use. Housing the data is one thing but who gains access is done through training program. We identify laboratory people who will be engaged but we run that through the VA. We have created teams, VA and DOE laboratory scientists, who are attacking the key problems that the VA has surfaced. The members of the teams that are allowed to access the data is controlled by the VA once we go through the training requirements, and so just housing the data doesn't give anyone access to the data. We worry about the control. We worry about the use of the data for the purpose and we monitor that through IRB processes as well.

So, you know, we've set up certainly an enterprise sensitive to the use and protection of the data for the very reason you remarked.

Mr. VEASEY. With—you know, with you putting in all those parameters to protect the information, are there any challenges to accessing the complete medical records of veterans when need be? I guess what I want to know is, is it easily accessible, quickly accessible in situations where it needs to be?

Dr. KUSNEZOV. So there are two parts to your question. Technically it is easy to access now in terms of the tool, the infrastructure we've set up, hardware and software, the learning environment. What is still a bit of a challenge is the IRB process. You know, what we've been doing here is new. Every step we take is new for everybody in terms of how we access data, and I think as we try and create the IRB structure for accessing veterans' data, we're sensitive to the fact that machine learning and artificial intelligence will kind of invert the world that people are used to. Normally when you have a researcher looking at data, they will pull the specific data they want to address a particular problem. If you're trying to learn from more than 22 million veterans' health records that span decades from genomic data, from images and so on and apply machine learning, the way you access the patterns of use are quite different than how anyone else has ever looked at this data, and so walking through the IRB and setting up the right protocols to allow access is a process that we're still working through. So we've done some. We can technically access the data. We have accesses and controls in place but the policy side, we are

still working through how we get everyone to think about where the future is in terms of learning from data.

Mr. VEASEY. Thank you.

Madam Chair, I yield back.

Chairwoman COMSTOCK. And I now recognize Mr. Rohrabacher.

Mr. ROHRABACHER. Thank you very much, and thank you to our witnesses today.

Let me just—this is not directly on technology, but it's dealing with a VA issue. Some of the things that you're describing that have motivated you to focus on trying to find technological solutions like depression, sense of hopelessness, et cetera, a lot of that can be traced, some of us believe, to the use of opiates by the VA, and some of us believe that the VA has taken the easy way out simply by prescribing opiates to somebody with a problem, which when we you supply that kind of drug, you're going to end up with somebody with serious problems.

Now, should the VA be permitted to use cannabis? Should they have that as an option rather than just opiates? And I've got some other questions that go directly to technology but could I have your opinions on that just a yes-no or something like that?

Mr. WORDIN. All right. I'll jump in.

Mr. ROHRABACHER. Okay. Should should cannabis be an option for VA in terms of treatment of our folks rather than just opiates—well, it's not just opiates? Do we know opiates——

Mr. WORDIN. I understand your question.

Mr. ROHRABACHER. Okay.

Mr. WORDIN. Well, I've been doing this for 10 years.

Mr. ROHRABACHER. Yes.

Mr. WORDIN. And I've had over 30,000 veterans come through my program, and I will tell you unequivocally that many of the veterans in our program use cannabis and they use it as an alternative to opioids, so——

Mr. ROHRABACHER. Is that good?

Mr. WORDIN. It seems to be working because they're all still alive.

Mr. ROHRABACHER. All right. Does anybody else have an opinion on that? Okay. I won't force you into commenting publicly on that. Okay.

Yes, there are controversial issues. I would suggest that it is sinful that we do not permit our veterans that option. The veterans, doctors that I know, countless—not countless. I know a number of veterans who the doctors have had to pull aside and go to them in an off-campus, you know, situation where they could then recommend marijuana, and it's ridiculous that we have to put doctors in a situation like that where they can't even recommend what they think is the right treatment.

Mr. Meek, you mentioned that it is difficult for medical devices to get approval. We find the same is true with commercial items as well like the FDA and others as well as other regulatory things. Could you give us a little more detail on that?

Mr. MEEK. Sure, and you talked about the FDA specifically and I'll reference the Ekso Suit, which is the primary device that we fund. You know, certainly you have to go through many phases of

the clinical trials. Then you have to go through different phases for FDA approval, and that takes years, I mean literally years.

Mr. ROHRABACHER. And people are suffering during those years.

Mr. MEEK. Exactly.

Mr. ROHRABACHER. And do you have an example of a device that was left behind or delayed so much that people were left to suffer?

Mr. MEEK. Well, again, not to beat a dead horse, but the Ekso Suit, you know, this has proven to—I mean, I know one specific veteran from Iowa who was told he'd never walk again and going through six months of rehab in the Minneapolis VA with a device we donated, he was able to walk his daughter down the aisle at her wedding. So it does work.

Mr. ROHRABACHER. Let me just note that I had serious troubles in my arms, and I know a lot of veterans get this as well. Actually all of the cartilage was gone. I'm a surfer and I ended up surfing all the cartilage away in my arms. I know how painful that was, and what's really helped is, I have had shoulder replacements that were, I believe, developed to help our veterans and now they've helped all of us. Do we have a situation where veterans are having to wait? Because I know how painful that was. Are our veterans having to wait to use the technology that we've developed?

Mr. MEEK. I think the question is whether they're actually getting the technology via the VA or through private facilities. So private rehabilitation facilities will get it much more quickly and it's much more accessible than going through the VA process of them going through the FDA approvals whether to get the funding or not, because it doesn't come from the VA here in Washington; it's each individual VA has its own budget and so it's up to them to figure out what they deem appropriate or necessary for their veterans' care and so that's where we step in.

Mr. ROHRABACHER. Well, new technologies and new medicines are really elongated in the process for us to use them, and when you mentioned batteries, about how new batteries will probably help and many of these challenges that we face are helping the disabled.

Let me just note that there are new batteries on the way, and Dr. Goodenough, the inventor of the lithium battery, has had a major breakthrough that should have an incredible impact on the things we're talking about, but then again, we have to make sure that the FDA approves the use of these batteries and everybody else approves the innovation all the way down.

So I'm very pleased that you alerted us to the bureaucratic problems that have to be overcome in utilizing new technologies for our veterans. Thank you very much.

Chairwoman COMSTOCK. Thank you, and I now recognize Ms. Esty for five minutes.

Ms. ESTY. Thank you, Madam Chairwoman. I want to thank the Chairwoman and Ranking Member Lipinski and Chairman Weber and Ranking Member Veasey for joining us here today.

As a member of both the Science, Space, and Technology Committee and the Veterans Committee, I want to thank all of you for your important work here today and give a real shoutout to Mr. Meek and SoldierStrong based in Connecticut, and we're really grateful for the work that you've done. All of us in Connecticut

know people who died in the Twin Towers, and that's a searing memory and your commitment to that. My niece was one of those who answered that call and served in Afghanistan, and I know how important the work all of you are doing.

I think it was you, Mr. Meek, mentioned no DARPA for the VA, and Dr. Major, you've also talked about the VA does not—has aging facilities doing research. So I have a couple of questions here so I'm going to ask all of you to say whether you think there ought to be a DARPA for the VA or rather whether we should be using DARPA as it exists but task them with VA-specific goals because that's what's happened around exoskeletons. I mean, that early work was around exoskeletons through DARPA. They've kind of dropped it. It's now been left for VA to pursue, so if people could opine on that, please?

Dr. MAJOR. If you don't mind, I'll begin. Yeah, I mean, essentially, in terms of funding mechanisms, we're obviously for additional funding, the typical way that the mechanisms run in the VA, there are certain priorities that research is directed towards. I mean, for instance, the prosthetic needs of women, for example, that's something that's come about mainly because of the growing population of women veterans, but essentially those type of priorities are fit into existing mechanisms, right, and I actually would look forward to something where there is maybe more targeted mechanisms, targeted funding mechanisms, speaking specifically towards certain priorities. DARPA may be a way to do that or some different formation similar to that which could be implemented in the VA, and I think that would actually be quite effective. Again, maybe not DARPA in and of itself but something that could work effectively in the VA that would allow individuals to target certain priorities, and I think that would help with the technology development, the advancement, and the implementation in the VA specifically which I think essentially is badly needed.

Ms. ESTY. Mr. Wordin, I know that actually under Dr. Shulkin, his only clinical priority was on suicide prevention. You've talked about a lot of feedback information. A question I have for you is, you're collecting a huge amount of important information, and much of it tracks with what we know anecdotally as well as, you know, the research beginning to be done about feedback. Do we have an ability to share or how would we go about sharing that important information that basically you're developing with the privacy concerns and as proprietary to you? And so here's part of the challenge. We have innovative work being done in the private sector in order to push it through all the VA. Then we have these questions about access, who has access to the data, how do we safeguard it and how do we share that information that you're developing that would help us develop better programs for veterans?

Mr. WORDIN. Okay. Well, that's a—I'll tackle that in pieces.

First off, under Secretary Shulkin and under President Trump, suicide prevention and mental health is the number one priority and yet they don't—there's no visible funding for technology that addresses those issues, not a single dime. So that's one area of concern that we have.

With the testing that we're doing right now, we're not collecting—we're collecting individual information but we're not iden-

tifying the individuals. So it's a blind study so there's no privacy concerns with that. With our program in general, we partner with the VA and we track particularly mental health status and suicide ideation of every participant in our program, and we have done that on a longitudinal basis for some time, and that information is contained or housed in their VA medical records so we're able to deal with the privacy in that regard. So as long as the VA medical records are private and they have security, then the information that we're gaining will have that same security.

Ms. ESTY. I want to follow up with you afterwards because we had some interesting testimony over in the Senate on gun violence issues and work that L.A. is doing through texts to deal with students who have suicidal ideation and other issues. So I think there may be alternatives that we can look at that have been developed elsewhere that could help marry the technology that you're developing to connect to, say, the VA hotline. You know, how can we have an ability to connect because that's one of those issues we've had. How do people even know about the VA hotline? Make sure you've got it staffed, I don't know if you've looked at that at all?

Mr. WORDIN. Well, actually, when we do have focus groups, and as the device has been developed, it has four options when you have a PTSD episode, whether it's self-resiliency or it's contacting a family member or a peer or whether it's contacting the VA hotline or 911, and what we find is that most veterans, I would say over 80 percent of veterans, would rather connect with a peer or a family member rather than a stranger on the VA crisis hotline.

Ms. ESTY. That tracks with all the other research we have that they'd rather have peers, so again, I'm over time but I really want to thank all of you for your important work on these initiatives and urge you to continue to bring your ideas forward so we can do a better job to serve those who have served this country. Thanks very much.

Chairwoman COMSTOCK. Thank you, and I now recognize Mr. Hultgren for five minutes.

Mr. HULTGREN. Thank you, Chairwoman.

Thank you all so much. This is really important. There's nothing more important that we could be doing than caring for our veterans, letting them have every opportunity for full lives that are fulfilling and continuing to be amazingly productive, so thank you for your work.

Dr. Kusnezov, if I could first address a couple questions to you. A unique feature of the DOE–VA partnership is that the Oak Ridge National Lab facility will be able to host protected VA health data. It's the only institution outside the VA to be able to do so. What steps is DOE taking to protect the personal information of our veterans? And also a follow-up, should DOE also be allowed to host secure data from other sources such as private industry?

Dr. KUSNEZOV. So thank you very much for that question. The data security piece is very important to us. Certainly, compliance with HIPAA and HITECH are important. We have a process we put in place to secure the data in the enclave. It includes an annual external review from a third party that reports back to the feds, and then we provide the authority to operate the enclave. We engage our cybersecurity and privacy experts and counterparts

from the VA to oversee all of this so we're very careful about data use and protection for this enclave.

Mr. HULTGREN. Do you think there is opportunity to host other secure data from other sources?

Dr. KUSNEZOV. These are things we already do across DOE for many different reasons from other agencies, for many different reasons, so yes. The simple answer is yes.

Mr. HULTGREN. DOE houses four of the top ten fastest supercomputers in the world and is the principal federal agency for leadership in computing facilities. How will providing DOE with access to the VA dataset benefit healthcare research specifically for veterans?

Dr. KUSNEZOV. I think what we've started to find in applying the basic existing tools and artificial intelligence is they break rather easily at the scales of the veterans' data set. The complexities, the size, the amount of information contained already exceed what standard toolsets are allowed to—you know, can accommodate. DOE is very interested in pushing the limits of technology and supercomputing and AI, and these kinds of stresses are very interesting to us in terms of where the next generation of more cognitive tools will come from. So we're going to be pushing this data. The data itself is the mechanism in which we set up this next frontier of AI-inspired simulation.

Mr. HULTGREN. Great.

Dr. Major, thank you for being here, grateful for your work, so proud of Northwestern, and incredible accomplishments that continue to come out of your work and others' work there at Northwestern, so thanks for being with us. Getting older brings with it many challenges including the danger of falls. Does your research provide any quantitative data on how much more of a danger this is to veterans in need of prosthesis or orthosis as compared to veterans who don't require such devices?

Dr. MAJOR. Thank you for the question. Yeah, I'm not particularly aware of any research that has targeted specifically veterans of that nature and what that distinction is between those again who do use prosthetic devices and those who may not in terms of fall and fall risk. That type of research I think is certainly needed. I think anything in terms of looking at specifically different types of veterans, the era which they come from, the combats in which they maybe perhaps served, I think that particular research certainly would be helpful in trying to target certain rehabilitation technology, whether it's prosthetic and orthotic devices or other types of rehabilitation technology in order to target that specifically to individual cohorts. I think it's something that can be done, and, you know, speaking again to some of the issues that were brought up today, the veteran statistics, the type of data that we have because it is such an integrative healthcare system, it's ripe for that type of research essentially that cannot be conducted necessarily on a wider scale.

I think the resources we have available to us through the VHA is just a perfect opportunity to do that type of work. Some of which is currently being done, but again, I think we could take better opportunity of that.

Mr. HULTGREN. Great. Quickly, Dr. Major, if I can follow up. Clearly, our goal is to continue to improve the quality of life of veterans but also for all people. I wonder with your research and work in prosthetics, how is it making its way to companies that develop such devices that could benefit from your findings and in turn provide better technologies to veterans and to all people?

Dr. MAJOR. So one of the benefits that we have is oftentimes the partnerships that we develop through a lot of these research efforts so just to use an example, my research in particular, even though it is directed through VA funding, it also includes partnerships with academia, for instance, so Northwestern University, and in addition to that, even industry partners as well, so much of the technology that is developed and the patents that are then developed through those efforts are jointly owned, right, so it would be owned by the VA as well as industry partners or academia as well. And so that is a way, that's a method in which the technology that is developed by funding supported by the VA that then can be brought out and benefit civilians. So we do a lot of that, in fact, and I think it's a great mechanism.

I will say that, you know, in terms of technology transfer, I think if certain mechanisms could be developed within the VA to help that, to help advance that process would certainly be beneficial because there is a lot of great technology that is developed in the VA, and these efforts and the funding through the VA does support that but I think trying to get that out to the civilian population would certainly be of great benefit.

Mr. HULTGREN. I'd love to see that.

My time's expired. Thank you all so much for your work. I yield back.

Chairwoman COMSTOCK. Thank you, and I now recognize Mr. McNerney for five minutes.

Mr. MCNERNEY. I thank the Chair. I thank the Committee for having this hearing, and I have to say, I got excited listening to your testimony.

Let me start with Dr. Kusnezov. A federal government scientist who had worked for the VA since 1983 made more than $400 million when he sold a company for $11 billion to this pharmaceutical giant Gilead in 2012. The drug was then discovered with federal resources and intended to treat veterans with Hepatitis C but, unfortunately, once the drug was sold to the private company, it was out of reach for veterans and for the VA both. So as the VA and the DOE work together with the private sector, how do we also ensure that the data and technology resulting from taxpayer resources and labs is not exploited by startups and private sector entities solely for the commercial gain for a few individuals?

Dr. KUSNEZOV. Thank you. No, that's a great question. In our partnerships, there are some fundamental tenets we have. One is open source for the tools we create for the very reason you mentioned. We do have some partnerships with pharma, for example, with GlaxoSmithKline right now, an effort called ATOM, also related to all of this activity. What we do in the space with pharma and the technology companies is precompetitive so it's by definition open to other entities to join and openly available and accessible for that reason. So we're sensitive to the question you're asking,

and we have to manage the middle ground in a suitable way so that it does draw in the right kind of risk mitigation from the private sector, which adds value to this, but does not do this at the expense of others. And so we are keeping an eye on it, again, open source and precompetitive are foundational here.

Mr. MCNERNEY. Okay. Well, I mean, we've seen this happen in other cases too so it's a very difficult situation when veterans can't have access to medicines that were developed with federal money. We need to work on strengthening those protections.

Mr. Wordin, I was pretty excited about your PTSD alarm, and you're using data, and the graphs you showed saw a spike in the heart rate and then additional sort of physical indicators after that. Were you able to identify in those cases the physical event or the emotional event that triggered those reactions?

Mr. WORDIN. We aren't able to do that but we asked the participants in our study right now to keep a journal, and they were able to document what the environment was. We try to look at both immediately before, a few minutes before, and maybe a half-hour before, and it's great empowerment to an individual veteran to understand what causes a PTSD episode for them because it's different for each veteran.

Mr. MCNERNEY. Absolutely, and if—I mean, if you could understand what's triggering it, then that leads to all kinds of opportunities for treatment and mitigation of those sorts of triggers.

Mr. WORDIN. Absolutely, and the great thing about the device is, it will measure that and see if what you're doing to mitigate is actually working or whether you see whether the prescription drug or the therapy options that the VA or your healthcare provider has given to you, you can objectively understand how it's working, what is working, if it's working, and so it's—I mean, that's the great thing about the device is, it's completely objective. It is what it is.

Mr. MCNERNEY. And do you see similar sort of characteristics, you know, data characteristics, from different individuals with regard to PTSD triggers?

Mr. WORDIN. Well, yeah. I mean, when you look at the spike, if that's what you're referring to, yes. I mean, that's a common theme. If someone's having a PTSD episode, that's how the device detects that PTSD episode is through that spike in heart rate or the heart rate variation.

Mr. MCNERNEY. Well, we saw a spike and then we saw a little bit of quiet period and then we saw additional——

Mr. WORDIN. That was—yeah, because we—the graph that you're referring to, that showed physical activity, because I wanted to differentiate, because one of the questions I always get is, how does it know whether it's physical activity or whether it's a PTSD episode, and the device is able to detect because the steepness of the curve when you're having a PTSD episode versus when you're, say, riding your bike, there's a different in how your heart rate elevates and how fast it elevates.

Mr. MCNERNEY. Thank you. I yield back.

Chairwoman COMSTOCK. Thank you, and I now recognize Mr. Webster.

Mr. WEBSTER. Thank you, Madam Chair. Thank you all for appearing. This is great work you're doing and we really appreciate it.

Mr. Meek, you talked about—I don't know your exact words but you talked about the fact that technology was ahead of the VA's practice in a sense and that you get these technological advances that are not a part of the normal VA treatment. I would assume—I don't know this is true but I make the assumption that advances in technology usually cost more, and that if it does more, probably costs more, but my question would be, how do we balance that? How do we mold together availability and advancement so that—I mean, you could have the scenario where you make an advancement, and if you spend all your money making advancements, then you could come up with something that helps a veteran 10 times better than current practice. However, you could only afford one out of 10 where under the old technology, you could afford 10 out of 10. Is there a balance there? Do you see what we might be able to do to—we certainly want to make advancements but we also want to be able to pay for it.

Mr. MEEK. Sure. So I think to go back to your other question about whether the DARPA should be a model to transform to the VA, I think it should be. You know, we put the most advanced technology we can in our warfighters, but once it's done meeting DARPA specs for the battlefield, that's it, the funding stops. There's nothing to commercialize that for the private sector back at home, and so you look at a lot of these devices. I mentioned how the average cost that we fund is $100,000 with a couple of them almost $200,000. Think about the original cell phone. It was the size of a small suitcase, you know, and cost a thousand dollars. Well, today it's the size of a calculator and it fits in your pocket, and it's a supercomputer. So having that continued research and development on a specific device, whatever it may be, for advancement, you know, where the funding comes from, there are separate pools that we could look at but you have to keep that funding going because over time it will bring costs down. You know, a lot of these devices are so advanced that yes, they cost a lot right now but 10, 20 years from now, knowing some of the work that Dr. Major's doing, you know, they're hardwiring some of these devices in individuals' brains. You know, I've seen virtual reality where somebody lost their arm in Vietnam, and through virtual reality actually felt himself opening a doorknob, and he cried because it was the first time he touched something in 25 years.

So this funding has to be found somewhere, because in time, not only will it reduce the cost of those devices, it's going to reduce cost of medical and VA care for those patients.

Mr. WEBSTER. Well, I saw a live presentation of the type of technology you showed in your video, and I was just totally astounded someone could actually go from a sitting position and rise with no help at all, not even necessarily using their arms. They could just get up. So I want everybody to have that. It's just the idea of making it available. It's expensive, and sometimes that would come at the expense of any more technological advances.

I had another question. That was Mr. Wordin. You mentioned—this doesn't have anything to do with that particular issue, it has

to do with self-directed mental health care, which I have—you said something about that, I don't know exactly what you said, but it struck a note that that's what you were talking about in that the person would help in the direction of what they would be choosing for their mental health care. I have seen that work in the private sector. Do you think that ought to be more uniformly applied in the VA?

Mr. WORDIN. I don't know if I'd use the word "uniformly" but I think it needs to be available because every veteran that suffers from PTSD is different. If you've seen one veteran with PTSD, you've seen one veteran with PTSD, and I think what they find as their support system individually is the most important path, and the great thing about the HEROTrak device is, it gives them feedback individually so then they can make decisions for themselves based on how their quality of life is that they want or that they have right now. And so if you go to the VA and you see your mental health clinician and he goes well, how are you sleeping; well, I'm not sleeping so good; well, we're going to give you some Ambien. Well, how do you know whether that actually does any good for you? Well, with the device, you're able to monitor and look at sleep patterns, look at PTSD episodes during sleep, and be able to decide whether or not that's something—because every prescription drug that you take has a side effect or it has some kind of addictive quality, and that affects your quality of life as well.

I mean, we have veterans in our program that literally have suitcases full of prescription drugs that the VA sends them on a regular basis, and then when they get into our program, they get off of those prescription drugs and yet the VA continues to send them the prescription drugs, and when you talk about costs for technology, technology is way cheaper than prescription drugs.

Mr. WEBSTER. Yes. That's not shocking. That's awesome.

Thank you all for appearing, every one of you. It's been very encouraging, each of you and your work. I yield back.

Chairwoman COMSTOCK. Thank you, and I just want to take a little prerogative too on that particular point, that if you can send us some of those examples with whatever way that protects the patient's privacy, that would just be really helpful in us making this case, because I think this is great disruptive technology that is going to save money, and the more we can highlight examples like that, I think as we move forward.

So I now recognize Mr. Dunn for five minutes.

Mr. DUNN. Thank you, Madam Chair. I love these joint Committee meetings where we're all gathered. It sort of underscores our interconnectedness. You know, we're sitting here with the Energy Subcommittee, the Research Subcommittee. We're talking about quantum computing for our national labs and it's being applied to translational genomics, and all this on the subject of yet another committee, Veteran's Health, so that's the interconnectedness that's great.

I'm a urologist—Dr. Kusnezov, I'm a urologist. Prostate cancer is very near and dear to my heart. I know you're working on ways to determine biomarkers that determine the lethality, relative lethality of prostate cancer, what needs to be treated and how aggressively. Can you briefly outline a couple of those for us?

Dr. KUSNEZOV. I can talk more to the technology side than the side that you might be more familiar with.

Mr. DUNN. Oh, yes. I want to know the biomarker, but I do appreciate what you're doing, and I think that that's—you know, I think that that's key.

Mr. Meek, you've partnered with VA hospitals, also I suppose military hospitals like Walter Reed? No, they're completely separate from you? Of course, they don't need your help, so you've partnered with the VA hospitals. How do you select which ones?

Mr. MEEK. So we work with the device manufacturer, you know, depending on what the device is. So if it's for an individual, sometimes they fall through the VA cracks and the device manufacturer will find somebody that maybe the VA won't fund it or the VA will fund the device but not the fitting and so they'll reach out to us to fill that void.

In terms of the exoskeleton devices, again, we work with the manufacturer. There are 24 spinal cord injury medical facilities within the VA center, and so we start with those that have the largest population that they serve with the goal of hitting all those with one device to begin with and then go back and circle back again. So, for example, Richmond, Virginia, serves the largest with 5,000 spinal-cord-injured veterans. They have one device. They could use 25. Palo Alto has 3,000 to 4,000 veterans that they serve. They could use a few devices as well. So one doesn't cut it. It's a rehabilitative device where somebody goes in like going to the gym with a personal trainer and you set your 45-minute time and you do laps around the VA.

Mr. DUNN. All right. And do you also—when you do provide one of these exoskeleton whatever type suits to the veterans, do you also provide continued support and maintenance upgrades?

Mr. MEEK. We do. When we purchase it, it also comes with a four-year warranty as well as training for the entire staff at the VA.

Mr. DUNN. And you mentioned regulatory burdens. I just want you to know that we have been tasked by no less than the President to streamline the regulatory burdens so if you have regulations that you think are bad regulations, duplicative, get in the way, bring them to us. We love to get rid of regulations, especially bad ones.

Ms. MacCallum, you're sort of a people specialist. You deal with a lot of people in a lot of different strata. Have you—in your opinion, have you seen the VAs and the veterans themselves, are they receptive to some of these new technologies?

Ms. MACCALLUM. Absolutely, you know, but I think about the fact that just demonstrating with Sergeant Rose on the set—on our set, we were able to raise enough money to buy an Ekso Suit for a veterans hospital in one day. So I just think that the awareness that people need to have, and also I think the partnership between public and private entities is so important, and I think about the new VA bill that is moving its way through Congress and where the gaps exist, and the VA can't provide that assistance. They are now allowed to turn to a private entity in order to fill that gap, and I think we need to look for more ways to do that so that private enterprise and the VA can work most efficiently together, and then

I think you'll see a scaling up of this technology in private facilities and in veterans facilities, and I think that the will of the people in terms of what we've seen is certainly behind it. And I also think that when you look at the cost-benefit analysis in terms of taking care of veterans long term, and you just heard what Mr. Wordin said about the incredible expense of pharmaceuticals, this psychological benefit and life benefit of these devices hopefully will make some of those pharmaceuticals unnecessary.

Mr. DUNN. Well, I share your optimism, and I thank you for the gratuitous plug for the Mission Act, the VA bill that we're carrying across the finish line right now. It's near and dear to my heart. I sit on that committee as well.

Looking at 20 seconds left on the clock, and it's not fair to bring up the question, Mr. Wordin, that you brought up so cogently in your report of the stigma that we attach to PTSD and TBI in not just our veterans but in our active-duty troops, and this is a major, major problem that we have just been whistling past the graveyard on. If we could treat it perfectly, we still aren't allowed to diagnose our active-duty troops lest we ruin their careers, and we don't have time for you to comment on that but I'm glad you brought it up, and——

Mr. WORDIN. If I could, I'd like to say one thing about——

Mr. DUNN. With the Chairwoman's permission.

Mr. WORDIN. One of the things that we found in testing, one of the things that was brought up to us by the VA is that vets wouldn't want to wear a HEROTrak because it would cause a stigma just for them wearing a device, but because it's an Apple Watch, it makes them cool, and so the stigma has been removed, and therefore they're getting help that they wouldn't ordinarily get. So we're very aware of stigma in our organization and the vets that we service and, you know, you've got to find creative ways to get around it.

Mr. DUNN. Thank you very much. I yield back.

Chairwoman COMSTOCK. Thank you, and it's gathering general information that's good for health and wellbeing along the way too, right, so, excellent.

I now recognize Mr. Palmer for five minutes.

Mr. PALMER. I thank the Chairwoman. I'll be fairly brief. I have to preside over the House in a few minutes. But Ms. MacCallum, looking at your involvement in this, I really appreciate how this started with SoldierStrong providing things to the soldiers in the field. Some good friends of mine's son, Lance Corporal Thomas Rivers' sister started that program and sending everything from sporting magazines to staples to essential things, and they got to the point where her brother would get things and the other guys would say well, you know, could you share that, and it turned into a program called Support Our Soldiers. Unfortunately, Lance Corporal Rivers was killed in the Helmand Province on April 28th, 2010, an IED, but the program continues and has expanded, and we're having a banquet next Thursday night, the annual banquet. These programs are incredibly important for morale but also for the families. A lot of these guys don't get letters from home, they don't get things from home, so thank you for what you're doing.

Mr. Wordin, in your testimony you mentioned that Project Hero has reduced participants' use of prescription drugs and opioids and others and antidepressant use significantly, and Mr. Dunn brought this up as well about—I think the process of dealing with these soldiers begins before they get home. The whole thing about PTSD, all of that begins before they get home, and one of my concerns, we've got 22 veterans per day that commit suicide, and I just have to wonder how much of that's related to reactions to drug use and what you're trying to do to reduce the dependence on drugs I think. Mr. Wordin, could you comment on that, how you think that might help us reduce what I think is an unbelievable tragedy that's occurring every day with veterans?

Mr. WORDIN. Sure. When you look at the report that's going to come out, the risk factors that they looked at—worsening of health status and decline in physical ability—those can be directly related to prescription drug use, particularly when you have overprescribing of prescription drugs, and it's not working, and therefore you start losing hope, and then it starts depression and then you're on the downhill spiral and then eventually that's what leads to suicide. So that's where I think the prescription drug use comes into play is because for doctors, the easiest solution is here's a pill, this is going to make you all better, whereas that's not necessarily what's in the best interest of that individual, and I think that's one of the great and exciting things about the HEROTrak is, you're going to be able to figure out what's in the best interest of the individual and be able to prescribe for that person a healthcare path that is actually going to make a difference for him.

Mr. PALMER. Well, I thank you. I told Mr. Norman if he would yield to me, I would hold to three minutes. I think I came pretty close to that, Mr. Norman, and with that, Madam Chairwoman, I yield back.

Chairwoman COMSTOCK. Okay. We'll now recognize Mr. Dunn—Mr. Norman. I'm sorry.

Mr. NORMAN. Thank you so much. Thanks to each of you for taking the time to testify. It's valuable.

I'll emphasize what Dr. Dunn said. As you move forward, if you see regulations that are impeding what you do, let us know because we've got a body here that is strong and will take your case to get needless regulations out of the way. It's a goal of the President and it's a goal of this body, this House.

Ms. MacCallum, you've got an interesting role, as they described, in the people business, as an anchor and on the advisory board. What is your opinion on this and what's been your experience on the specific technology for veterans that is effective with raising money and raising the awareness? Is there one or two that you could point to?

Ms. MACCALLUM. You know, I just think when people hear the stories of these veterans the impact that it has on their lives, you know, here's one veteran, Jason Geiger, who was a SoldierStrong Ekso Suit beneficiary. He said you cannot put a price on walking, you can't put a price on someone's ability to be six feet tall again and stand up and kiss your wife or stand up and hug your daughter or your son. You can't put a price on that. And we talk a lot about money because we have to because it's part of bringing this

technology to our veterans but, you know, I think there's a will in America—I know there's a will in America to provide for this, and I do think that people are very much aware—you talk about regulations—of the waste that exists in the federal government in its, you know, good efforts in many ways to solve some of these problems but I think everyone sitting here is working towards efficiency and improving the lives of our veterans, and I think that through technology and through awareness, a lot of these ideas can help us to cut some of the waste in these programs and to produce more benefit.

Mr. NORMAN. And that's—you know, we don't know what we don't know, and as—I'm glad you brought up waste because every agency, particularly now, can give us a roadmap as to where there is waste and specifics on how we can address it, and I hope you all will do that as you move forward because every dollar saved through waste goes back—would go back into potential good use.

Mr. Meek, how did SoldierStrong decide which VA hospitals will receive the SoldierSuits?

Mr. MEEK. So again, we worked with the device manufacturer, and within the VA medical system there are 24 facilities that have a spinal cord injury unit. In addition, we also work with those that have a traumatic unit as well, and so the spinal cord injury unit will be focused more on spinal cord injury versus traumatic could focus on stroke, and so we'll take the recommendation from the device manufacturer with the goal of getting those that serve the largest population a device first and then going from there.

Mr. NORMAN. Okay. Perfect. Thank you all. I think we're at about 12 o'clock. We really appreciate your testimony. I yield back.

Chairwoman COMSTOCK. Thank you so much, and I thank the witnesses for their testimony today and the Members for their questions. Without objection, Chairman Weber and Ranking Member Veasey's openings statement, which they were not available to make when we started the hearing, are made a part of the record.

[The prepared statement of Mr. Weber follows appears in Appendix II]

[The prepared statement of Mr. Veasey appears in Appendix II]

Chairwoman COMSTOCK. And I really so appreciate the great testimony here today. I think we're really seeing disruptive, positive, innovative technology, and I think there's no question that we need to reallocate resources, get new resources, and make sure we're providing this choice because a lot of the things we're talking about with our veterans and what we're trying to improve are more veterans choice, and what you're offering is more choice and more positive outcomes, and I really do think it's a lot of win-win solutions that you have here. So we look forward to working with you on how we can redirect and reprioritize this so we actually end up with better outcomes that will ultimately most importantly save lives but also save money. So this is real exciting, and I think this is the beginning of what I hope will be continued discussion on this. We're already discussing maybe some legislation and efforts that we can work on with our colleagues here on this Committee who are also on the Veterans Committee. So thank you for your inspirational work.

And the record will remain open for two weeks for additional written comments and written questions from Members, and this hearing is now adjourned.

[Whereupon, at 12:05 p.m., the Subcommittees were adjourned.]

Appendix I

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. Dimitri Kusnezov

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

"Empowering U.S. Veterans Through Technology"

Dr. Dimitri Kusnezov, Chief Scientist, National Nuclear Security Administration, U.S. Department of Energy

Questions submitted by Ranking Member Eddie Bernice Johnson, House Committee on Science, Space, and Technology

1. The federal government has made significant investments across a number of agencies to advance our nation's competitiveness in data analytics and big data science. Congress funded the VA-DOE Big Data Science Initiative at approximately $10 million in FY17, with DOE providing $3.4 million and the VA providing $7 million. The FY19 budget request for BDSI is $27 million, nearly three times the FY17 funding level, all of which would come from the VA's budget.

    a. If Congress funds the program at the requested $27 million, what is the plan for this investment? Specifically, what will each agency's role be, what is DOE's contribution to supporting BDSI, and what is the timeframe for implementation?

    Answer: The FY19 VA requested $27 million funding is the next step in the agency-to-agency program that was launched in early 2016 and broadened in 2017. In April 2018, DOE Secretary Perry and acting VA Secretary Wilkie signed a comprehensive memorandum of agreement (MOA) detailing expectations of next steps in this agency-to-agency effort that currently involves eight DOE laboratories, VA investigators and the use of ESNet.

    The scope of the FY19 effort, as outlined in the MOA, is the basis for the planning that will involve DOE's next generation artificial intelligence, big data, and high-performance computing technologies, as well as multi-modal diagnostics and data integration, in order to develop specific VA identified priority areas and goals. DOE's investments will include: development of next generation artificial intelligence hardware and software capabilities, additional data sites that can accelerate the technology advancement and veterans impacts, and multi-lab teams drawing from the diversity of skills found around the complex.

    Through our joint VA-DOE workshops, the VA has identified high-impact health priorities including improving predictive models for suicide risk, prostate cancer, and cardiovascular disease and improved care for Post-Traumatic Stress Disorder and Traumatic Brain Injury, among others. VA's substantial and complex data from the breadth of its ongoing research will feed the advancement of DOE's artificial intelligence and big data objectives, and together, these efforts will push the frontiers of precision medicine.

2. The information collected for the Big Data Science Initiative is very sensitive personal information. Almost 600,000 veterans have voluntarily donated DNA samples to the VA's genomic program. How will the VA and DOE work together to implement federal requirements for cybersecurity? Are there any challenges to accessing the complete medical records of veterans that are willing to provide it to BDSI? As you may be aware, there are proposals that have come before this body that may result in an increase in veterans seeking healthcare services from providers outside the VA system. Could this potential change affect the accessibility of this dataset or our unique insight into the veteran population?

   Answer: DOE has Protected Health Information (PHI) data storage and computing enclaves around the DOE laboratory complex, and for this effort has launched a computing environment specifically for the handling of private health information for research. There are several components to this Big Data Science Initiative (BDSI), which includes data aggregation from non-VA sources that can accelerate advancement of both DOE and VA goals, in addition to the VA data itself. Among our current data resources, the VA Corporate Data Warehouse and genomic data are located at DOE's Oak Ridge National Laboratory (ORNL). Traumatic Brain Injury (TBI) data and images are housed at Lawrence Livermore National Laboratory, with TBI data also being planned for Argonne National Laboratory.

   The PHI enclave at ORNL was designed using NIST 800-53 R4 and NIST 800-66 control guidance as well as Center for Internet Security guidance. It is considered a Moderate with Enhanced controls environment by Federal Information Processing Standard 199 rating due to the additional implementation requirements from the Health Insurance Portability and Accountability Act Security Rule and the Health Information Technology for Economic and Clinical Health Act. These controls are attested to by a 3rd party on an annual basis. This PHI data enclave architecture and protection measures have been jointly discussed with VA Information Security Offices to ensure compliance with VA information security guidelines found in the VA Handbook 6500. DOE's Chief Information Officer and privacy officers have been involved in reviewing the initial PHI enclave at ORNL and is involved in the broader scope defined in the VA-DOE MOA.

   Aside from the physical and cyber security protections, DOE and VA have put together joint teams focused on the priority areas listed in the prior response, and data access needs are limited to those working to meet these goals. Independent Review Boards are also engaged prior to any access to ensure data access is well understood.

Changes in veterans' use of VA healthcare services will not affect the programmatic efforts outlined. The VA houses one of the most valuable health datasets in the world that includes the Electronic Health Record (EHR) of nearly 24 million veterans. In addition, the VA is currently building one of the largest and most comprehensive medical databases with the addition of newly collected DNA samples through their Million Veteran Program (MVP). The size of this dataset pushes the limits of VA infrastructure and expertise in large-scale data workflows, analysis, and computation; thus, necessitating the DOE-VA collaboration.

Appendix II

Additional Material for the Record

OPENING STATEMENT SUBMITTED BY SUBOMMITTEE ON ENERGY
CHAIRMAN RANDY WEBER

COMMITTEE ON
SCIENCE, SPACE, & TECHNOLOGY
Lamar Smith, Chairman

For Immediate Release
May 22, 2018

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Statement by Chairman Randy Weber (R-Texas)

Empowering U.S. Veterans Through Technology

Chairman Weber: Today, we will hear about the Department of Energy (DOE) and the Department of Veterans Affairs (VA) collaboration on an early-stage research program that will utilize DOE's unique capabilities in big data analytics, artificial intelligence (A.I.), and High Performance Computing (HPC).

The DOE and VA national research program, housed within the agencies' Big Data Science Initiative, is called—and it's a mouthful—the Million Veterans Program-Computational Health Analytics for Medical Precision to Improve Outcomes Now or MVP-CHAMPION.

The MVP-CHAMPION initiative provides VA researchers access to DOE's HPC research facilities and scientific expertise, while the DOE receives access to a massive collection of data from the VA.

VA patients volunteer genomic and health care data that uploads into the enclave. Part of the data includes the deepest levels of DNA sequencing that allows for high quality genomic research. With a rich and expansive dataset, the VA Million Veteran Program provides an incredible opportunity to use DOE's next generation computing capabilities to solve complex healthcare challenges.

Oak Ridge National Laboratory is leading the effort to store VA data in a secure enclave developed at the lab.

Through DOE's Energy Sciences Network, or ESNet, eight national labs can securely access this data. This allows DOE scientists and VA researchers to work remotely and collaborate from sites around the country.

As the VA transfers more data to the enclave, researchers can leverage the HPC infrastructure within the national laboratory system to analyze the data.

The application of artificial intelligence, machine learning and natural language processing for computational science has the potential to surpass the algorithmic models used by current data scientists.

For example, the ability to predict an outcome through computational modeling yields both raw input data and experimental output data in equally large amounts. The accuracy of the outcome remains limited by the ability of a human researcher to ascertain the most salient features from the data, leaving the majority of data unused.

A.I. and machine learning can do what a human researcher cannot, and can use all of the vast amounts of data and explore complex relationships and produce previously unseen results. A.I. has unlimited potential to combine big data analytics with computational modeling that can produce more accurate predictions.

For the VA, this means predicting the health care needs of VA patients. For the DOE, this application of computer science tools could transform basic and early-stage research. DOE's core mission areas are full of complex, big data challenges like physics, environmental systems, combustion and nuclear weapons modeling. DOE also has the potential to enhance its expertise in biosciences and materials design.

Experience working with big datasets and applications in data science has the potential to improve computational science methods for any big data problem. And with the next generation of supercomputers, the exascale computing systems DOE is expected to field by 2021, DOE will be able to tackle even bigger challenges.

Increasing computing power will expand HPC capabilities and improve the quality of computational research for any big data set or complex problem.

Ultimately, the goal of MVP-CHAMPION is for the DOE national laboratories to provide the VA with information it can use to improve health care services for veterans. The access to the breadth, depth and complexity of the VA dataset will also advance the next generation of data science tools.

It's clear that DOE is the right partner for this important research. I look forward to hearing more about the unique assets DOE has to improve the VA health care delivery system and transform fundamental research in the years ahead.

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OPENING STATEMENT SUBMITTED BY SUBOMMITTEE ON ENERGY
RANKING MEMBER MARC A. VEASEY

OPENING STATEMENT
Ranking Member Marc Veasey (D-TX)
of the Subcommittee on Energy

House Committee on Science, Space, and Technology
Subcommittee on Research and Technology
Subcommittee on Energy
Empowering Veterans through Technology
May 22, 2018

Thank you Chairwoman Comstock and Chairman Weber for holding this hearing. Thank you to the witnesses for being here today. As a member of the Armed Services Committee with over 18,000 veterans residing in my district, I'm aware of the sacrifices our service members make every day. As a nation, we must repay our veterans for their military service by easing their transition from military to civilian life. I'm pleased by the VA's partnership with the Department of Energy to harness the power of Big Data. This partnership will use the VA's data sets on service member health and DOE's supercomputing resources to identify trends that will be useful in treating conditions unique to service members.

With this data, we may be able to identify a veteran's risk for certain conditions or develop new treatments and prevention strategies. This partnership, known as the Big Data Science Initiative, will apply DOE's work on large-scale data analytics, computer modeling, large-scale machine learning, and natural language processing to a very real need. I look forward to hearing Dr. Kusnezov speak about the areas of research and development that will be required to address these issues.

I am also interested in learning more about advancements in prosthetics and exoskeletons that will preserve the independence of older and younger veterans alike. The work DOE has done in the realm of 3D printing and advanced manufacturing will undoubtedly make these devices stronger, lighter, and more affordable. I anticipate these advances will bring relief to many veterans suffering devastating losses of mobility.

Finally, the use of wearable technology and virtual reality to monitor and treat PTSD shows major promise. With as many as 1 in 5 veterans who served in Iraq or Afghanistan suffering from PTSD, the need for better treatment is clear. Work done at universities across the country, including in my home state of Texas, will lower the barriers to treatment for many veterans. By monitoring stress levels and finding creative solutions to allow veterans to speak more freely about PTSD, we will be able to preserve the lives of countless veterans. I look forward to hearing more from all each of our panelists on these important topics.

Thank you again, Madame Chair, and I yield back the balance of my time.

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