NASA AND NEUROSCIENCE: AN EVOLVING PARTNERSHIP

Remarks by NASA Administrator Charles F. Bolden, Jr.

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My thanks for that introduction and good morning to you all. Like so many others, I have the privilege of serving our country during this time of challenge and change facing most of the executive agencies under President Obama's leadership. For NASA, it is a time of bold new directions, new capabilities for America's space program, and a renewed commitment to research and technologies that, if sustained by the Congress, will assure American global space leadership for generations to come. It is a time for achievements – and challenge.

Those technological pathways will give NASA the foundation for advanced robotic and human spacecraft capable of leaving our planet behind and voyaging far beyond the moon into deep space. That, I am sure you've heard about or read about following the release of the President's FY2011 budget request. But behind many of those technologies are uses that you may not have heard about, uses in your neighborhood clinics, hospitals and Doctor’s offices. These more terrestrial applications promise near term results that can return value to the taxpayer and improve the quality of medical research here at home. This little known aspect of NASA research is among the most important work that we do.

When our agency was founded a half century ago all that we had was a vision of where our technologies could transform America. It took a visionary leader to set forth an extraordinary goal before the world that would galvanize NASA. That goal was man to the moon, and the visionary leader President John F. Kennedy. But while President Kennedy was committed to making America first in space, he was also committed to assuring Americans that space research and exploration had features that would improve the qualities of their lives and the lives of their children. He set this prospect before the public in an important speech on space he gave on November 21, 1963 dedicating the Brooks Aerospace Research Center in San Antonio, Texas. Sadly, it was the last time our 35th President would speak about the space program, for 24 hours later he would be assassinated.

“Many Americans make the mistake of assuming space research has no value here on Earth”, Kennedy said, adding, “Nothing could be further from the truth”. He predicted that medicine in space “is going to make our lives healthier and happier here on Earth”.

The President gave three examples for his prediction, made at a time when the longest U.S. manned spaceflight was only a day and a half in space. He predicted space medical research would lead to greater understanding of man’s relation to his environment, in areas such as causes and effects of disorientation, changes in metabolism, and how the environment of long duration space missions might alter human physiology. Second, JFK said space research might result in technologies and tools for use on Earth, such as new monitoring systems to track heart rates, brain waves, accelerometers, and new ways to understand childhood illnesses such as eye diseases by the use of new technologies created from space equipment. And lastly he predicted protecting astronauts from space radiation might result in new treatments for diseases that involve radiation therapy.

Each of these predictions was incredibly bold for the time, and each of them and much more have come true. Today, research aboard the International Space Station is growing as the station nears completion and a full crew of six set to work in its laboratories. President Obama’s recent challenge to NASA to send astronauts to inspect asteroids in deep space, and to orbit the moons of Mars give increased importance to research in radiation protection for astronauts. To make the trip, we will also need vastly improved structures and propulsion systems, all of which have yet to be invented, along with a new class of heavy lift booster to send them there. President Obama's faith in NASA's ability to solve these and many other challenges facing astronauts in the 21st Century mirrors President Kennedy's belief in the value of space research in medicine made in a time when technology itself was limited by today's comparisons. And that faith in our capabilities as a global leader in medicine, science, and technology is also rooted in a whole series of NASA programs that have yielded benefits to space explorers as well as practical, nearer term uses.

None are more extraordinary than NASA's work in neuroscience research. Space neuroscience is a division of space life sciences research that seeks to understand the effects of space flight on the human nervous system. It uses the microgravity environment of space to improve our understanding of how the nervous system functions under normal gravitational conditions. Earlier space life sciences research focused on the health and safety of the astronauts. But research conducted aboard Shuttle missions created new opportunities to develop space neuroscience, and to design Earth-based research to improve techniques for conducting neuroscience experiments in space. As more astronauts of both genders fly in space for longer periods of time, utilizing the laboratory capabilities of the International Space Station, we will be able to improve our understanding of gravitational forces in space, and learn more about normal function as well as disease.

NASA space neuroscience research began in the Gemini and Apollo era with more comprehensive studies on Skylab. This research resumed on our SpaceLab missions in1983 and continued with a dedicated mission aboard Shuttle Columbia in 1998. The physiologic challenges of spaceflight remain unchanged since these early Shuttle missions. Space motion sickness – or space adaptation syndrome - can be treated in-flight. Crewmembers often return from their missions with difficulties in maintaining balance. Standing upright after spaceflight can be difficult due both to labile blood pressure and unstable posture. Muscle mass is reduced. Some astronauts often sleep poorly. Many of these symptoms reflect major underlying changes in the nervous system. Aboard Space Shuttle Columbia in 1998, the Neurolab mission addressed a number of these issues in a comprehensive way, asking for example: How does the information from gravity sensors in the inner ear get reinterpreted in microgravity? Has nervous system control of the circulation been altered?

How have circadian rhythms been affected? Does microgravity cause neuroplastic changes in the nervous system and what is the mechanism? Can the quality and quantity of sleep be improved? Does spaceflight change the way blood pressure and brain blood flow is regulated? Neurolab research studied both people and experimental animals to find answers -- recording everything from the crewmember's ability to catch a ball, to changes in gene expression in the rat brain. Particularly important were a new series of investigations in the area of mammalian neural development, which may be key to sustaining crew health in long duration, deep space missions: Is gravity necessary for normal development? How do muscles and their neural connections develop without gravity? Will the vestibular system develop normally? Are there critical periods in development when gravity is essential? Will animals walk properly if these skills develop in space?

These are basic questions about nervous system development that can only be performed in the microgravity space environment, and Neurolab was only the beginning of such dedicated research, with 26 experiments conducted in eight teams. More investigations into these areas will be conducted aboard the ISS.

Neuroscience research has continued in the laboratories at several NASA field centers, including the Ames Research Center, Johnson Space Center and Jet Propulsion Laboratory. At JPL, we have made great strides in the use of sensors to determine the effectiveness of tumor surgery. Researchers have developed special electronic sensors and computer algorithms for processing the digitized outputs of sensor data for determining whether tissue exposed during neurosurgery is cancerous. These sensor outputs compliment the visual inspection by a surgeon. These techniques could go a long way for an intraoperative technique for determining whether all of a brain tumor has been removed. The electronic sensor systems could complement multimodal imaging techniques, which have also been proposed as means of detecting cancerous tissue. There are also other potential applications of these techniques in the diagnosis of abnormal tissue.

NASA uses infrared technology to map the Earth's surface and search for distant objects in the universe. Infrared technology also has uses by first responders and in the military. Physicians have used infrared technology for mapping the roots of skin cancer, but it has never been used for brain tumors until now. Since tumor cells emit more heat than healthy ones, Doctors at the Keck School of Medicine of the University of Southern California in Los Angeles are using a JPL- developed camera and infrared imaging in trials. They're trying to see if they can sketch tumor margins by detecting temperature changes during surgery, since tumor cells emit more heat than healthy ones. High-resolution infrared images could map temperature differences among the issues. This non-invasive procedure is an adaptation of the software systems now in use to identify features on Mars and the moon from orbiting reconnaissance spacecraft. It measures heat energy from patient's tissues without the use of X-rays or other intravenous procedures. There doesn't even need to be contact with the brain at all.

We are also advancing brain tumor research by the use of carbon nanotubes. Nanotechnology may help revolutionize medicine in the future with its promise to play a role in selective cancer therapy. A nanotube is about 50,000 times narrower than a human hair, but its length can extend up to several centimeters. The research aims at discovering whether nanotubes could more efficiently and selectively deliver drugs and other medicines directly to the affected areas of the body.

If NASA researchers can mature this technology, it might also be used to treat stroke, trauma, neurodegenerative disorders and other disease processes in the brain. The nanotubes, used on mice, were non-toxic in brain cells, did not change cell reproduction and were capable of carrying DNA and siRNA, two types of molecules that encode genetic information.

JPL's Nano and Micro Systems Group grows the nanotubes on silicon strips a few square millimeters in area. The growth process forms them into hollow tubes as if by rolling sheets of graphite-like carbon.

Carbon nanotubes are extremely strong, flexible, heat-resistant, and have very sharp tips. Consequently, JPL uses nanotubes as field-emission cathodes -- vehicles that help produce electrons -- for various space applications such as x-ray and mass spectroscopy instruments, vacuum microelectronics and high-frequency communications.

With completion of the International Space Station in sight, and with a full complement of six astronauts working on the station, the use of this national laboratory to advance space medicine research is only just beginning. Increasing our understanding of how the space environment effects human neurological functions, by a combination of in-space experiments and use of the many and varied laboratories at NASA field centers across the nation, is key to living and working in space. It is a partnership that has yielded many dividends and promises to advance the state of space medicine even farther in the years ahead – as far as our imagination can take us. Much progress has been achieved since President Kennedy's vision of space medicine. But there remain new areas of research and new applications of technology if President Obama's emphasis on space research and technology development is pursued. NASA and our research partners are advancing human capabilities in space one mission at a time. I invite you to join us in this evolutionary quest.

Thank you.