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Diabetes: An Investor's Perspective

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Abstract

Total health care expenditure in 2006 was $2.1 trillion. This figure is estimated to double within the next few years as the cost of treating diabetes and other chronic conditions continues to rise. Moreover, the baby boomer demographic is anticipated to place an enormous burden on the health care system and employer-based health insurance premiums were increased at rates as high as 10% per year in 2006.

The quest to address these challenges has also created opportunities for investment, particularly in the fields of telemedicine, health care information technology, and medical technology.

The author shares his business perspective, informed by years of experience as a physician and astronaut at NASA, and describes new applications of exciting technologies that deliver effective and efficient health care to diabetes patients, no matter where they may be.

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Introduction

As a former NASA astronaut, whenever I tell people that I have been in space, most often they ask me the question: "What in the world would make a physician decide to become an astronaut and then later get involved in various business ventures?" My answer is as follows.

It all started in my childhood. I was about 9 or 10 years old, growing up during the time that we were in a race with the Russians to see who was going to get to space first and, later on, to see who would make it to the moon. In 1969, when I was 13 years old, the Americans landed on the moon. I hope everyone remembers this milestone event. Younger people may have just read about it in the history books, but I saw it all on black and white television and I heard these words: "One small step for man, one giant leap for mankind." Here I was, this little boy enamored with space, science, and science fiction. When I saw this and I heard those words, I decided that I wanted to be an astronaut.

Of course, at about the same age, I would also watch *Star Trek*. There was this character who was an astronaut and doctor called Leonard McCoy, the chief medical officer of the starship Enterprise. He was the first person I saw

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Abbreviations: (NASA) National Aeronautics and Space Administration, (PDA) personal digital assistant

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who practiced space medicine so I decided to follow in his footsteps. In reality, the person who was a trailblazer for physicians interested in space science was a man by the name of Joe Kerwin. Joe was not the first physician to travel in space. The first physician in space was Russian. They were ahead of us back in those days. But Joe did fly 28 days on Skylab 2. Again, I was just a young boy during this exciting era, but I was certain that this indeed was what I wanted to be involved with: the efforts to ensure human survival in space. Dr. Joe Kerwin became my mentor.

I don't know how many people are aware of the difference between practicing medicine in space and here on earth.When a patient comes to my office, I usually say, "Hello, Mrs. Johnson, come in and have a seat on the table." In space, you simply say, "Joe, float this way!" Things are a little different there. There is no need to worry about turning the patient around because there is no up or down in space. It does present a number of challenges as well. For example, if you will be examining a crew member in space, you will have to tie them down first or tie yourself to them, but that is a different subject altogether.

When astronauts are selected as crew members, they all get together in a room to decide on the insignia for their mission. My second mission was to go to the Russian space station. This would have been the first time for a shuttle to rendezvous with the Russian space station so the patch we designed for this mission has a depiction of our shuttle docking with the Russian space station. It has the American and Russian flags on the bottom. Also, we used symbols to commemorate the mission number of 63—six rays of the sun and three stars. The most important feature of this patch is that it bears the name of every crew member of this mission. That is very important because in my business, I need evidence to prove that I actually went into space.

Let's talk about space. Everyone has seen a rocket being launched into space but only a number have actually experienced space travel. The *second* question I get asked most often is: what is it like to travel in space? I will start by saying that the vehicle weighs approximately five million pounds. It therefore takes a lot of force to get it into the air. That force comes from five engines that produce 7.5 million pounds of thrust. I guarantee you that when those engines light, you will definitely be leaving the planet and there is nothing that will hold you down! It is a very violent ride and very noisy. You are pushed back by a force approximately three times your weight caused by the acceleration of the shuttle. It accelerates so quickly that within 2 minutes, you will find yourself 100,000 feet above the earth. At this point, the space shuttle jettisons the solid rocket motors and the external tank as the orbiter continues its ascent into space.

The view from space is *awesome*. It takes only 8 and a half minutes to get there. A lot of energy gets dissipated as you approach orbit. How far did we go in 8 and a half minutes? To give you an idea, Mission 63 lifted off from the Cape but when I got out of my seat, walked over to the window, and looked down, I found myself staring at Europe. In order for us to enter orbit safely, we must reach a speed of 18,000 miles per hour. At 18,000 mph, we are able to go around the world in just 90 minutes. You will see the sun set or the sun rise every 45 minutes. Space is a great place to go and visit. I enjoyed my time as an astronaut.

I learned a lot while in space, especially in the field of space adaptation—changes that occur when a human body that has developed here on this gravitational field is taken to a place that has no gravity. When an astronaut enters space, his proportions and dimensions change almost instantly. An astronaut of normal weight, finely chiseled features, and neat hair can suddenly morph into a swollen-eyed, puffy-cheeked creature with unmanageable hair. Every astronaut experiences these changes to varying degrees. One element of this transformation is caused by a fluid shift. On earth, when a person is standing, approximately one-fifth of the body's blood volume remains in the lower extremities because gravity holds it downward. The size of blood and the amount of blood in the body are dependent on gravity. Likewise, the size of the heart is also dependent on gravity because it is responsible for circulating the blood. When a person travels into space, the fluid that was forced downward by gravity is now free to move up toward the head. The fluid enters the tissues of the face, the neck, and the brain, producing a number of signs and symptoms, like the puffy cheeks. How does it feel? One might feel stuffy because the fluid also gets into the nasal passages.

You may have heard that you can actually increase in height when you go into space. This is true. I have experienced growing an inch or two myself. We believe that this is because fluid is taken up by our vertebral discs and causes them to swell. In addition, with the loss of gravity, there is no longer the weight of the body compressing the spine and as a result, you end up growing an inch or two.

My subspecialty is space medicine. Space is actually a new laboratory and we use it for many studies. We have been able to discover and document many changes that occur in the human body by taking medical experiments onboard. Our hardware is capable of looking at several aspects—cardiovascular, hematological and musculoskeletal—of being in space. For example, we have found that an astronaut can lose approximately 1% of bone mass per month in space. The longest time that anyone has stayed in space is 422 days, a little over a year. In this case, it seems that this individual's bone loss could continue indefinitely. At this point, we are unable to determine when the bone loss will cease. We can also lose 15 to 20% of muscle mass. There are changes in the immune system. There are changes in white blood cell migration, which could impair our ability to fight off diseases as well as we do on earth.

Typically, an astronaut loses 5 to 10 pounds during a mission. This is mostly caused by that fluid shift explained earlier. When the body senses that there is fluid overload, it takes drastic measures to get rid of the fluid. This results in frequent urination for the first couple of days until the body has downregulated its internal blood volume. Consequently, this purging of fluid causes hemoconcentration, which suppresses red blood cell production in the bone marrow and causes sequestration in the spleen. Over time, this results in some astronauts becoming anemic. Most of these changes are the body's way to adapt to the environment of space, and as such are "normal" as long as you remain there. The biggest problems occur when you return to Earth.

To date, we have done very limited diabetes research. The screening process for astronauts markedly reduces the likelihood of a person with diabetes traveling to space. However, we can expect to discover many changes when the mechanics of diabetes and glucose metabolism are studied in-depth in space. It is only a matter of time, especially now with the international space station, that we will gain more insight into the human body as never before.

As a physician, I began my career as a researcher. Afterward, I became a clinician and an operator in space, conducting experiments in space. I had the opportunity to learn and analyze much information because I was involved in developing some of the medical hardware currently being used in the international space station. In addition to my clinical background, I gained research background experience of having developed technology for use in space. I eventually became the first physician at NASA who systematically studied and documented the changes in a human body in space, determining the norms for space flight. We developed techniques for examining people in space and even conducted the first telemedicine conference from space.

In 1996, I left NASA and decided to use all of this experience toward technology transfer and developing commercial products. I first worked with SPACEHAB, an aerospace company that promoted opportunities for research in space. We had a laboratory that flew in the cargo bay of a shuttle. Our clients were from both the United States and international organizations, such as the European Space Agency, Japanese Space Agency, Brazilian Space Agency, and others.

Sometime in 2000, I met Jack Gill, a true venture capitalist who introduced me to the world of venture capital. He is the founder and managing partner of Vanguard Ventures based in Palo Alto, California. He himself made a great deal of money and created a number of advanced technology companies throughout the years. He suggested that I look into venture capital, which is exactly what I did. In 2002, with his help and his firm's investment, we created a company called Vesalius Ventures. Our goal is to accelerate the future of medicine by bringing advanced technology to the delivery of healthcare. We are focused in the emerging market called telemedicine.

We do not define telemedicine as the typical remote medicine. It is not only doing two-way communications with people in rural areas or even in space. It has more to do with how technology can be applied in delivering health care and the use of medical informatics. The technology aspect of it is the back-and-forth transmission of patient information needed for diagnosis and treatment An example is the medical technology utilized for remote monitoring or implantable devices, which require the transmission of medical data. Telemedicine, health care information technology, and medical technology are of keen interest to us. Our sweet spot is finding opportunities that take advantage of communications, information technology, and medical devices, but with this caveat: the technology must provide effective health care to a patient, no matter where that patient is.

As investors, we are always analyzing the market. We believe that the time is right to invest in telemedicine because of a number of drivers and enablers. There is an investment opportunity in health care because of the rising costs in health care. This is both a positive

and a negative. It is a negative if you are responsible for paying your own health care insurance and you have to absorb the continual annual cost increases, which have been as high as 10% per year. From an investor's standpoint, however, this situation is considered a solid market. You can actually invest in the industry with some level of confidence. Other factors to consider are the aging population and the nursing shortage. One important development is the expansion of broadband communications. We now have broadband available even in personal digital assistants (PDA) and cell phones.

The cost in health care expenditures was $2.1 trillion in 2006. This is estimated to double within the next few years. As discussed in medical literature and in newspapers, the health care system will be significantly impacted by the disruptive demographic of baby boomers. If you consider all the baby boomers with chronic diseases such as diabetes and obesity, which are rampant in the nation, again, there is an opportunity for investment.

The following are only a few examples of the application of these exciting technologies in telemedicine today. Technology has allowed us today to build automated platforms: specifically, a very small computer that allows a patient to manage their chronic disease at home. Chronic diseases that can be managed using this platform include diabetes, cardiovascular disease, and hypertension. Algorithms in a clinical database can be used to ask the patient certain questions regarding their health. In addition, this technology can interface with various types of devices, such as the patient's glucometer, as a means to provide comprehensive medical care in the home. Utilizing Bluetooth technology or direct wire technology, these automated platforms can receive data from many different home medical devices, such as weigh scales, blood pressure cuffs, electrocardiograms, etc. As necessary, these devices, when connected through a television, can provide two-way communications with a nurse at a call center.

Also, there are other technologies for managing chronic disease that offer the ability for a physician's office to manage patients wherever they may be—at home, in the office, or traveling. Using a PDA, patients send their information to their doctor and, depending on the availability of broadband technology at their location, they can actually have a two-way communication with their doctor versus plain transmission of data. Everything is done via this technology, which even allows one to evaluate a patient remotely. The doctor has the entirety of the patient's data onscreen and is able to access all pertinent electronic medical records instantly.

For the management of Diabetes, advances now allow a Bluetooth-enabled glucometer to send information through a phone. The phone has a graph application that allows the reporting of the measurements onto the phone. At the same time, the phone uses texting technology to send information directly to a call center where the information is collected and stored. The phone uses the existing telecommunications network, which is supported by a nationwide service carrier, to transmit to the diabetes management call center.

During the last 5 years with Vesalius Ventures, I have witnessed the beginning of the evolution of healthcare, where technology has allowed the extension of healthcare providers' ability to serve the needs of patients more effectively and more efficiently. When fully realized, the application of these technologies will transform healthcare as we now understand it. That future begins today!

I have encountered many individuals (fictional and nonfictional) who, by their good example, have helped shaped my decisions in life. My mission in life is to continue to share my experiences and knowledge to create opportunities for people to work together, so that we may play a part in improving the quality of life of everyone here on earth and, of course, in space.