Good morning and thank you, Tyler. It’s my pleasure to meet all of you again.

Today, we are going to talk about something that truly fascinates me and that’s the topic of innovation, both innovation in general and innovation specific to healthcare. Without a doubt, I believe we are entering one of the most extraordinary times in human history. It is a time in which the world’s biggest problems are actually becoming the world’s biggest opportunities, a time in which we can solve every problem no matter how complex.
While it may seem that I am overreaching with my enthusiasm, I am hoping that those of you who are doubters will be influenced by today’s presentation and see how some amazing new possibilities for the future of healthcare and of mankind are going to impact us. In order to appreciate the reality of this new world, you have to have an understanding of the impact of exponential technologies. That will be our focus today.

Healthcare: The Way It Should Be

As many of you know, this webinar is part of a series of webinars we have been doing based on the book ‘Healthcare: A Better Way, The New Era of Opportunity’. Prior webinars covered the first 7 chapters of the book. Today’s webinar covers chapter 8, which is focused on looking into the future, specifically the role of innovation in healthcare. As entire webinars, we will go well beyond what is in chapter 8 of the book as we discuss the topic of innovation. For those of you who have not read the book, it’s okay. The webinar and the book are designed to be complementary. So you can read the book after the webinar. The book is available for free at the link listed on the slide. It is also available in Kindle and soft cover format on Amazon.
Poll Question #1
What is your primary functional area of expertise?

Let’s start with a poll question. Please take a moment to respond to this question. What is your primary functional area? Are you a clinician, executive, data analyst or architect, IT or other?

I’ll pause...

[Tyler Morgan]
Alright. We have that poll question up. We will leave that up for a few moments for everyone. For those of you who are just joining us, we would like to remind you that you can ask questions by entering questions in the questions pane of your control panel.

We’ll go ahead and close that poll now and take a look at the results.

Alright. Dr. Haughom, it looks like we have 9% clinician, 27% executive, 16% data analyst/data architect, 21% IT, and 26% other.

[John L. Haughom, MD]
Again, a really nice cross-section of talents. So thank you for that.

**Why Innovation Now?**

Healthcare organizations need innovation to address:

- Inconsistent **quality**
- Unacceptable levels of **harm**
- Widespread **waste**
- Unsustainable growth in **costs**
- Rapidly rising **demand**
- Looming provider **shortages**

Why Innovation Now?

Alright. Today, everywhere you turn, people are saying innovation is important. Why is that happening? Why is it happening now? In the past, many organizations have been able to survive even with very limited amounts of innovation. They focused on providing quality of products and services and simply updating those products and services to a level that maintain their competitiveness in the market. This is largely what we’ve done in healthcare. Recently, however, some trends have emerged that drive the need for more innovation, as well as innovation at a faster and faster pace. These factors include a marked growth in the complexity of the economic and social problems facing the world, the increasingly fast pace of change, a significant expansion in marketplace competition, and increasing globalization. As a result of these forces, there is an increased push to improve the efficiency and effectiveness of organizations through innovation in an unrelenting effort to drive down cost and improve productivity. Because of this, innovation is becoming an important competency that organizations in all industries must foster and one that all organizations need to include as a key part of their short and long-term strategy.
Several recently published surveys have reaffirmed the importance of innovation. For example, the 1600 executive respondents to a Boston Consulting Group survey rate innovation as a strategic priority with 72% of the executives rating as a top 3 priority. Also, research undertaken by McKenzie supports this finding, with their survey reporting that 84% of executives say innovation is extremely or very important to their company’s growth strategy.

While innovation has long played an important role in healthcare, it is becoming increasingly important right now. Finding innovative ways to deal with the challenges that we face has never been more important than it is today. We all know the challenges – inconsistent quality, unacceptable levels of harm, widespread wastes, too fast growth in cost, looming provider shortages, and rapidly rising demand.

With the passage of the Affordable Care Act, millions more people are flooding into our healthcare system. It is already strained by rising costs and a short supply of physicians, nurses, and other clinicians. There has never been a time in the history of healthcare when innovation is more important than it is right now. In fact, we will not be able to address the challenges like those listed on this slide without applying innovative solutions. Our industry is facing unprecedented need to change.

Innovation Definition

“The design, invention, development and/or implementation of new or altered products, services, processes, systems, organizational structures, or business models for the purpose of creating new value for customers and financial returns for the firm.”

Department of Commerce Advisory Committee on Measuring Innovation in the 21st Century Economy. Available at: http://www.esa.doc.gov/Reports/Innovation-measurement-tracking-state-innovation-american-economy
Innovation Definition

Innovation has been defined as “the design, invention, development, and/or implementation of new or altered products, services, processes, systems, organizational structures, or business models for the purpose of creating new value for customers and financial returns for the firm.” The breadth of this definition is noteworthy. Viewed comprehensively, innovation is not just about new or significantly improved products or services. It can also imply process redesign, new organizational models, new methods of service delivery, new ways of relating to customers, and new approaches to marketing. In healthcare, we’ve tended to focus primarily on innovation in products and services but less on innovation in other important categories. I believe that’s about to change.

Types of Innovation: Non-disruptive vs. Disruptive

Innovation can be categorized by its impact on stakeholders as either non-disruptive or disruptive.
Non-disruptive innovation, also referred to as evolutionary, incremental, linear, or sustaining, improves something that already exists in the way that supports the realization of new incremental opportunities or solves known issues.

Disruptive innovation, also called radical, revolutionary, transformational, or exponential, refer to innovations that fundamentally disrupt old systems, create new market constituents and new markets while marginalizing the old ones and deliver dramatic new value opportunities for those who successfully implement and adapt through the innovation. Disruptive innovation is a technology-driven paradigm shift that alters the economics and potentially the business model underlying a business’ products, services and operations. The internet and worldwide web are prime examples of technologies that have spawned disruptive innovation and myriad markets, like communications, music, advertising, movies, banking, and commerce.

While we’ve been largely insulated from the impact of exponential technologies in healthcare, a very compelling case can be made that healthcare will experience substantial disruptive innovation over the next few years.
Over the past two decades, innovation has become critical to economic growth and progress in all industries. This has been largely driven by the exponential growth in technology innovation. The explosion of the internet and mobile technology and the seemingly endless potential of the ways that they can be used is outstripping and sometimes undermining structures of living and working that have prevailed for more than a century.

There are a few areas of modern life that technology hasn’t altered. From our smartphones to our DVRs, to the GPS on our cars, technology has changed the way that we live, work, bank, shop, read, watch movies, and drive. The list is long and it’s growing steadily. And it keeps changing every day. These changes have had a big influence on how people live and how the business world operates. Its influence can be seen practically in all aspects of people’s day-to-day lives, as well as the day-to-day operations of businesses, both large and small. This revolution is removing commercial and technology barriers that have previously hampered free communication between people.

By challenging traditional business models, the convergence of readily available internet services and mass mobile devices has delivered unimaginable benefits to consumers and had a major impact on many industries. Mobility delivers choice for the customer and also lowers barriers to entry into markets for third parties.

What’s missing from this picture? Well, healthcare. While we are starting to see the impact of these forces, to date, the impact has been relatively modest. While there have been pockets of innovation, the healthcare consumer has not yet benefited from the rapid advancement of technology that has touched nearly every part of American life. That’s about to change.
What does exponential growth feel like?

To the casual observer, technology-induced innovation can seem random and linear. However, if one stands back just a little bit, a more dramatic pattern becomes apparent. The pace of the innovation is accelerating exponentially and it’s often exogenous to the economy. Entrepreneurs and scientists do not think or create more slowly during recessions or wars. In fact, innovation is often easier during downturns and difficult times. This is especially true of digital innovation.

So, here’s a question. What does exponential growth feel like?
A simple walking example illustrates the difference between linear and exponential growth. If you walk 30 paces in a linear fashion, you will travel about 30 meters. You will walk from one end of a room to another. Now, it’s important to understand that this is how the human mind works. We think and perceive the world in a very linear fashion. The reason the human brain is an advantage is that it helps us predict the future. When our ancestors were hunting a thousand years ago and saw an animal running in the distance going one way and we were going in another way, our brains evolved to allow us to correctly meet the animal where it was going to be and not in some other direction. This turned out to be good for survival. It was good to predict a linear future. As a result, this is how our brains evolved. This linear way of thinking became hardwired into the human mind. But those predictors that are hardwired into brains, what we call our intuition, is linear. It makes us believe that the things will continue to unfold or evolve in a linear fashion. But the reality of the information technology world is that it grows exponentially. It doubles every period of time. Instead of going 1, 2, 3, 4, 5, it goes 1, 2, 4, 8, 16, 32. This does not sound that different, but it is. If I say to you I wanted you to take 30 exponential steps, which is essentially 30 doublings, what would that look like?
Take 30 Exponential paces...

If we take 30 consecutive exponential steps, the length of each step would double the previous step for 30 steps. That is, 1, 2, 4, 8, 16, 32, etc. So how far will we travel over those 30 sequential steps?

If I take these 30 exponential steps, I’m not just back at the back of the room. I’ve traveled over 1 billion meters, which is the equivalent of traveling around the world 26 times. Because our brains are programmed to think in a linear fashion, it is hard for us to understand this reality. Clearly, the difference between individuals, organizations, or industries progressing linearly as opposed to exponentially is very dramatic. An organization or industry’s ability to see this and react to effectively is critically important. This will be true for healthcare organizations just as it has been in other industries.
Exponential vs. Linear Growth

If we were to graph the difference between linear and exponential growth, this is what it would look like. The red line is a linear progression. It is also us. It represents how we think. It is physicians, it’s nurses, it’s all care providers, it is executives, it’s our patients, it’s all of us. We are local and linear beings and none of us have had a softer upgrade for millions of years.

The black line represents exponential growth. It is the technology we are creating. It is the technology we use in our day-to-day professional and personal lives. It’s computers, mobile phones, networks, sensors, robotics, bioinformatics, artificial intelligence, and genomics. It’s the difference between these two lines, the red line and the black line, where it really starts getting very interesting.

For humans, the difference between these two lines is either disruptive stress or opportunity, depending on your point of view. For a group of 20 some things working in a garage who come up with a brand new way to provide a product or a service, it represents immense opportunity and we’ve seen many examples of that over the past decade. For the CEO of a Fortune 500 company that is threatened by their innovation, it represents disruptive stress. There are many examples of exactly this all around us today and we’re going to see more and more in the
future. The rate in which an idea can go from the conceptual stage to a billion-dollar company is getting shorter and shorter. Progress is moving faster and faster.

Let’s look at a real-world example of this phenomenon to put it in context.

Understanding Exponential Technology...

This is a picture of Peter Sasson. He is holding the world’s first digital camera. You will note that it has a resolution of 0.01 megapixels. There’s a story behind this picture that helps explain the impact of disruptive innovation on organizations and how some can view exponential technology as disruptive while others can view it as opportunity. Let’s take a look at that story.
The competent question here is Kodak. Kodak was a 100-year-old company; historically, had been remarkably successful. In 1996, it had a market capitalization of $28 billion and 140,000 employees. Kodak had been amazingly successful and it was clearly a brand recognized around the world. What many people do not know is that 20 years earlier in 1976, Peter Sasson, who was a Kodak employee working in Kodak’s research labs, developed the world’s first digital camera. You saw a picture of it in the last slide. Peter introduced his invention to the Kodak executive team and board, explaining, here’s the future of Kodak. Their response? The executive team and the Kodak board essentially said, “You’ve got to be kidding. We’re Kodak. We make very detailed high resolution photographs. We are in the film and development business. This is a toy for children. It takes just 12 pictures in black and white at 0.01 megapixels. How could we possibly drive margins to make a profit with this thing?” Kodak leaders did not understand the power of exponential growth of technology and they chose to ignore this new technological development. This was clearly a mistake.

Because 20 years later, that same digital camera caused Kodak to file for bankruptcy in 2012. They had shrunk from 140,000 employees to only 17,000 employees. To put an exclamation point on this story and give you context about the impact of exponential technology, in the same year, 2012, another company in the image business, called Instagram, was acquired by Amazon.
Facebook for $1 billion. It is noteworthy that Instagram has 13 employees. This represents a moment in time when a company that thinks in a linear fashion gets displaced by a company that understands the power of exponential technology. Some have referred to this as “The New Kodak Moment.” We are seeing this over and over and over again. It is occurring at a faster and faster rate.

You might ask yourself, will this happen to healthcare organizations? Will it happen to my organization?

Examples of Disruptive Innovation

Beyond Kodak, there are numerous other examples of the impact of disruptive innovation on organizations. The internet and worldwide web are prime examples of technologies that have spawned disruptive innovation and myriad of markets. Examples shown in this slide include telephony with Vonage and Skype, downloadable music - iTunes, search and advertising - Google, streaming media - Netflix, financial transactions - PayPal and E-trade, personal and business communication - Gmail and Net Meeting. In each of these areas, the pace of change has been breathtaking and caused massive disruption. Consider music. Downloadable music in
MP3 format sold through iTunes and Amazon decimated the CD industry of over just a few years. Now, iTunes is being seriously threatened by a new kid on the block that just appeared over the last several months, streaming music and companies like Spotify. Apple recently announced that its iTunes revenues had dropped 13% due to the impact of streaming music just over the past few months, explaining why Apple hurriedly spent $2 billion on Beats, allowing Apple to acquire a streaming music capability.

The point of all these is straightforward. Driven by exponential technology, the pace of change is increasing. These trends will continue to destroy organizations just as they did at Kodak. As a more recent example, consider Borders and Barnes & Noble. Borders has disappeared, Barnes and Noble on the ropes.

In 10 years it’s predicted that 40% of the Fortune 500 companies will no longer exist

These powerful trends in exponential technology are driving a different kind of mass extinction. This is from the Babson School of Business and it predicts in 10 years that 40% of the Fortune 500 companies will no longer exist. Think of that. 40% of very large companies won’t exist. If that’s even half true, it’s amazing. These powerful trends will impact all industries, including
healthcare. The question you have to ask yourself is, which organizations will be able to adapt and which will not survive. Will your organization be able to adapt and survive these trends?

Exponential Growth of Computing

Why is this happening now? Why not 50 years ago? Why not 50 years from now? What is driving the pace of change? Where is it coming from? In order to answer the "why now" question, we need to have a sense of the history of technology. It helps us explain why we are entering the most exciting phase of human history. This graph is from Ray Kurzwell’s bestselling book, ‘The Singularity is Near’. On the X axis, its time is plotted, covering about 110 years. The Y axis shows the amount of computing power that you can buy for $1,000. Now, it’s important to note that the Y axis is a log-rhythmic scale. Because it is log-rhythmic, each increment represents 10 times the previous increment. Each dot on the scale is a computer that was developed at that time in history.

There are two things to point out about this graph. The first is how smooth the line is. Over the last 110 years, you do not see ups and downs due to major economic advances like the great depression or other major world advances, like World War I or World War II. You see a pretty
constant curve, a curve illustrating successively faster computers being used to develop even faster computers. This suggests that no matter what goes on in the world, this progress in exponential technology will continue. One other point about this graph. A log scale of this line should be straight. However, you can see that it curves upward. This suggests that the rate at which computers are getting faster is itself getting faster. That is, the rate of exponential technology and innovation is actually increasing over time.

If you look at computers 100 years ago, it took 3 years for them to double in power at the same cost. In the 1950, it took 2 years. In year 2000, it was 1 year. Now, it’s 11 months.

The exponential growth of technology innovation can be seen in a lot of other parameters as well. There are literally hundreds of examples. But let me quickly walk through a few of them. The number of transistors per chip has been growing exponentially for the last 40 years.
Processor performance over the same period of time, measured in Millions of Instructions Per Second, has also been growing exponentially.
Internet Data Traffic

The internet data traffic has been doing the same.
And consistent with the massive global spread of mobile phone technology, mobile data traffic has been growing exponentially as well.

As I said, I could show you dozens of other examples illustrating this exponential growth in technology but I think you get the point. Progress in technology is growing exponentially. It is a very powerful trend and it’s changing the world.
Another way to look at this exponential progression is in terms of brain equivalence or intelligence. The computer that I created this presentation on and that I’m currently using to show you the presentation operates at over 200 billion instructions per second. In the 1960’s and 1970’s, this computer would have been viewed as a super computer. Now, think how often over the past decade we’ve all walked away from computers and cellphones that vastly exceeded the power of computers in the 1960’s and 1970’s without giving it a second thought. A new more powerful computing option comes along at the same price as your last device, so we eagerly move on to the latest technology. The one you are giving up would have caused tens of millions of dollars in the 1960’s. Yet, it only costs as a thousand dollars now and we think nothing of walking away from it when the next technology comes along. A year from now, we know we can buy another one for the same price that will be twice as powerful.

Nine years from now, in 2023, the computer you’ll buy for a thousand dollars will calculate at 10 to the 16 instructions per second. Now, this is just a number until you talk to a neurophysiologist who will tell you that that is the rate at which the human brain thinks. What does it mean when the average computer you can buy for a thousand dollars is calculating at the same rate as the human mind? And of course, it does not stop there. In 2050, the average computer you can buy for a thousand dollars will probably be computing at the rate of the
entire human race. This is why you’re hearing so much about artificial intelligence these days. What does that level computing power mean for humanity? What are the implications? In truth, we don’t know. However, it will clearly have huge implications. It will help us address some of the world’s most pressing needs. The most difficult problems we face, the environment, energy, water shortages, world hunger, will suddenly be solvable. But computers this powerful could also impose threats to humanity. What happens if they start viewing humans as a liability side to turn to us. People are actually starting to express concern about that. Stephen Hawking did exactly that just a few days ago. Scientists, ethicists and others have begun debating whether this level of computer intelligence is a good or a bad thing. Only time is going to tell.

Has Technology Advancement Mattered?

Clearly, technology has been advancing for a very long time. It is having a dramatic impact on the world. Yet, one could ask the question. Has progression in technology been a good thing or has it been a bad thing? If you talk to people, opinions are mixed on this issue. Some people think the world is getting worse and that technology is responsible. They argue that things were better and the people were happier before technology. This is a bit of a romantic notion. People who say this do not really know what life was like 200 years ago. Writers like Charles
Dickens accurately described life 200 years ago when life expectancy was only 37 years, when there were no safety nets, not because people were not liberal enough but because not enough money was available. Life was actually extremely difficult in 1800.

Let’s examine what has happened to humanity over the past 200 years as technology has revolutionized the world. In order to do that, I’m going to show you a nice little tool that’s an animation.

So I’m going to switch over to this.

[Animation starts at 29:10]

This application is from GapMinder, a non-profit that promotes sustainable global development. You can download it and have it on your own device at the website illustrated on this slide. The circles are countries. Their size reflects population size. I want to have you follow three of the circles on this as the animation falls, versus this yellow one, which is the United States, this red one which is China and the blue one which is India. You can tell the countries by the color-coding app in the right-hand corner on this map.

The data is depicted in two dimensions, health and wealth. GDP or income per capita is on the X axis. Wealth is income per person measured in 2009 American dollars. In 1800, income per person could be measured in hundreds of dollars. People were actually quite poor. There is a
range, some countries were more wealthy and other countries less wealthy. While there was income disparity 200 years ago, no one was very wealthy in 1800. On the Y axis, health is measured in longevity and life expectancy. As you can see, in 1800, most people lived into their late 20’s or 30’s. The worldwide average was only 37 years old in 1800.

So, what happened to health and wealth over the last 200 years? To illustrate that, I’m going to play this animation.

1800 was the start of the industrial evolution. Machines started to be used in manufacturing. It started in England in the textile industry. These industrial techniques quickly spread to other countries. In the 1900s, we began to see a trend that carries all of the countries to the upper right-hand corner of the graph. Health and wealth have significantly improved by this time. In the United States, life expectancy has reached 79 years of age and income per person is now about $40,000, thousands of times what it was in 1800.

There is still disparity between countries in terms of health and wealth but everyone has improved. The countries that are worse off are actually much better off than the countries that were best off in 1800. It is important to realize that this is not the end of this process. In fact, it’s speeding up. As technology continue to progress exponentially, health and wealth will continue to improve at an increasing rate toward greater health and greater wealth.
Let me switch back now to where we were.

The Singularity is Near

Okay. If you would like to learn more about this, I would encourage you to read the works of Ray Kurzweil, particularly his best-selling book, ‘The Singularity is Near’. All of Ray’s books are fascinating and cover basically the same general topic that we just briefly reviewed.
Poll Question #2
Within how many years do you anticipate exponential technologies will significantly impact healthcare?

Okay. Our next poll question. Within how many years do you anticipate exponential technologies will significantly impact healthcare? Four choices. Less than 2 years, 2 to 4, 5 to 7 years, or more than a decade.

Tyler, I’ll let you time this.

[Tyler Morgan]  
Alright. This poll is up. Again, within how many years do you anticipate exponential technologies will significantly impact healthcare? While we’re answering this, I would like to remind everyone that you can write in your questions or comments in the questions pane of your control panel.

Alright. We’re going to go ahead and close this poll now and let’s share the results.

Okay. Dr. Haughom, it looks like 34% responded less than 2 years, 36% 2 to 4 years, 21% 5 to 7 years, and 9% greater than 10 years.
**Historical Healthcare Innovation**

- Historically, innovation in healthcare has been **linear**, not exponential
  - Examples:
    - Warfarin vs. Pradaxa
    - Open Cholecystectomy vs. Laparoscopic cholecystectomy
    - Coronary artery bypass graft (CABG) vs. Cardiac stents

- Going forward, expect **disruptive** (exponential) innovation in non-traditional categories
  - Examples:
    - Automated, intelligent care environments
    - Genomic-based personalized care
    - New technology-enabled care models (ambulatory- and patient-centric)
    - Integrated delivery organization design (ACOs)

**Historical Healthcare Innovation**

Now, let’s focus in on healthcare innovation. Historically, the majority of innovation in healthcare has been centered on the development of new diagnostic procedures, therapies, drugs, or medical devices, something that US has excelled at over the past few decades. These advances range from new pharmaceutical agents and procedures like stents to more precise diagnostic scanners and surgical robots. Examples include things like improved anticoagulants, warfarin as opposed to Pradaxa, open cholecystectomy versus laparoscopic cholecystectomy, surgical coronary artery bypass graft versus cardiac stents.
While these innovations have produced some stunning results, they have been relatively narrowly focused and mostly incremental in nature. Going forward, the emphasis on innovation in healthcare promises to accelerate rapidly and produce exponential change in important areas, including more automated intelligent care environments or personalized care tailored specifically to a patient’s genetic profile, more efficient and proactive technology-enabled care models, more integrated and comprehensive delivery organization designs, and additional creative technology-enabled options for effective health encounters. We will review various categories of disruptive innovation in healthcare later in this presentation and in future webinars.

Harnessing the Power of Exponential Technologies

Faster, Cheaper, Computing Power

Ubiquitous Networks
Ubiquitous Sensors
Artificial Intelligence
Robotics
3D Printing
Synthetic Biology
Materials Sciences
Digital Medicine

Harnessing the Power of Exponential Technologies

Faster and faster computers, greater and greater computational power is the foundation on top of which many other amazing advances are being built. As computers get faster and faster, all digital processes get faster and faster as well.

So we will see explosions and other scientific endeavors such as those listed on this slide. These and other scientific endeavors will all ride in the wave of Moore’s Law, resulting in massive progress over the next decade. While each of the disciplines listed on this slide have very broad
applicability, they will also have major implications for healthcare. Many of them will also have major implications for healthcare analytics. In future webinars, I will cover many of these areas in some detail and talk about their implications for healthcare analytics.

Today, let’s take a quick look at just a couple of the genomics and sensors to get a sense of their likely impact on healthcare.

As most of you know, computer code is a set of computer process instructions that uses the binary number system. The binary number system consists of two binary digits, 0 and 1. In essence, computer code tells a computer what to do. It defines its function.

Genetic code is a set of instructions that facilitate gene function and gene expression. Genetic code consists of four primary nucleic acids which determine the proteins a gene can produce. These four nucleic acids are Cytosine, Guanine, Adenine, and Thymine. They make up key components of DNA structure and the specific sequence of these nucleic acids define a gene’s function. Now that the human genome project has successfully determined nucleic acid sequence of the human genome, health and medicine are becoming an information technology,
essentially, learning the software of life saying this is not a metaphor in abstraction. We literally have software programs running in our body, 23,000 of them. They are called genes. As we better understand genetic code, we are putting the technologies in place that will allow us to alter genes. This essentially means we will be able to program life and health. Biology is now in the early stages of the historic transition to an information science, while also gaining the tools to reprogram the ancient information systems of life. Few of us go more than a few months without changing the software programs in our computers or smartphones. Yet, the 23,000 software programs inside our cells, called genes, have not changed appreciatively in hundreds of thousands of years, maybe millions, and there are numeral ways that this will be helpful in treating a disease and promoting health.

The Tale of Two Mice

One example of a gene that we would like to turn off is the fat insulin receptor gene which tells fat cells to hold on to every calorie. Most humans have this gene. Basically, this gene says, hold on every calorie because the next time hunting season may not work out so well. A thousand years ago, this was a very good idea. You are to hunt and work all day to get a few calories to keep yourself alive. There were no refrigerators, so you consume what you got and it was stored in the fat cells in your body. This was a good idea then. But now, some of us would like
to tell our fat insulin receptor genes, I’m confident that my next hunting season in the supermarket is going to be good. So you don’t have to do that anymore. This has actually been tried in mice at the Joslin Diabetes Center in Boston. With a gene that was blocked in the fat cells of mice during the study, those mice ate a lot but remained thin and healthy like the mouse on the left. They lived almost 20% longer, obtaining the benefit of caloric restriction without food restriction.

There are other examples of genes we would like to block. For example, there are genes that have been identified that are necessary for cancer and heart disease to progress. There are also examples of diseases caused by missing genes that we would like to insert in the DNA of patients who lack them.

These are just a few example of thousands where reprogramming our bodies can improve health and life.

Now that biology is becoming an information technology, it is subject to what the accelerating recurrence that is a characteristic of exponential technologies. Information technologies,
including biologic ones, double their price performance and capacity in less than a year. This has clearly happened in the case of genomics. For example, as illustrated on this slide, sequencing DNA has come down in price by half annually from $10 per base period in 1990 to under a penny today.

DNA Sequencing Data

In addition, the amount of genetic data we have sequences more than doubled every year. This progress is making a big difference. It took us 15 years to sequence the HIV virus but we sequenced the SARS virus in 31 days. This rate of doubling means that we will increase the capability of these technologies by a factor of a thousand in less than a decade and by a billion in 25 years. As this data is accumulative, it will have huge implications for the future of healthcare analytics.
A few days ago, William Barnes, who listens to our webinars routinely, emailed me to ask if I thought wearable sensors would have an impact on healthcare. As the technology for collecting, transmitting, and analyzing data continues to evolve at an exponential pace, we will certainly see more creative wearable sensor-driven applications in healthcare, spanning the continuum of care from hospital to clinic to the patient’s home and to the workplace. These solutions will not only be driven by healthcare needs but also by consumer demand and market forces. I believe the impact of sensor technology in healthcare will be massive and the impact is closer than we may think. There are literally thousands to medical sensors, either on the market or underdeveloped. Those pictures on this slide are several examples of this trend. This contact lens in the upper left hand corner is being developed by Google and MIT. It has a built-in glucose monitor and wireless capabilities. Instead of periodic finger sticks, this contact lens will allow diabetics to continuously collect their blood sugar data and wireless transfer the information to their smartphones and then potentially onto their care provider.

Researchers at the University of Illinois have developed an implantable skin mesh of computer fibers thinner than a human hair. You see that illustrated on this middle slide. It is essentially a tattoo that can monitor the body’s physiological function from the surface of the skin. Finally, the Gates Foundation is supporting an MIT project to creating the implantable contraceptive
device controlled by an external remote control. The tiny chip generates small amounts of contraceptive hormone from within the woman’s body for up to 16 years. Implantation is no more invasive than a tattoo. Women will be able to turn it on and off using their smartphone, depending on whether they do or do not want to get pregnant. All of us will have significant implications for healthcare analytics as it will make vast amounts of new health and wellness data available to healthcare providers. We will cover wearable sensors in much greater detail in my January webinar. So stay tuned for that.

Sensory Data Means Big Data

With the fire host of information enabled by Facebook, Twitter, location-based services, and other forms of social media, the era of big data is definitely upon us. However, outside of the consumer world, the stakes are actually much higher. While advertisers and consumers are focused on monetizing size that have hundreds of millions of users for a few pennies each, the ubiquity of connectivity and the ubiquity of sensors will open up a larger storehouse of information that will not only help businesses profit but also enable better understanding of some of the world’s most complex problems, including those in healthcare. This sensory-enabled world will generate massive amounts of data for analysis.
For example, sensors are already heavily used in the aviation history. A Boeing jet generates 10 Terabytes of information per engine every 30 minutes of flight. So for a 6-hour flight cross-country from New York to Los Angeles on a twin engine Boeing 737, the total amount of data generated would be a truly massive 240 Terabytes of data. There are about 28,537 commercial flights in the sky in the United States on any given day. Using only commercial flights, a day’s worth of sensory data quickly climbs into the Petabyte scale in a single day. A Petabyte is 10 to the 15 bytes or a thousand Terabytes. Multiply that by weeks, months, and years and the scale of sensory data gets truly massive, going into the Zetabyte scale. I do not have a healthcare example for you yet but those are going to be coming soon. The point is that once tens or hundreds of millions of people are wearing one or more sensors, it will generate truly massive amounts of data and very much propel healthcare analytics into the realm of big data. This will present enormous opportunities to organizations that can use this information about patients, their behaviors, and their environments. It will be groundbreaking and tremendous when we can do that.

Poll Question

3. Who will drive the sensor revolution in healthcare?
   120 respondents
   a. Consumers – 27%
   b. Employers – 1%
   c. Payers – 4%
   d. Health systems – 2%
   e. All of the above – 67%

Poll Question #3
Who will drive the sensor revolution in healthcare?
Okay. It’s time for another poll question. Who will drive the sensor revolution in healthcare? Consumers, employers, payers, health systems, or all of the above?

I’ll pause.

[Tyler Morgan]
Alright. We’ve got that poll question up. Who will drive the sensor revolution in healthcare? Consumers, employers, payers, health systems, or all of the above? I would just like to remind everyone that they can type in their questions and comments in the questions pane of their control panel. We’ll leave this open for just a few more seconds and then share the results with everyone.

Okay. We’re going to go ahead and close that poll right now. And here are the results.

Dr. Haughom, 27% answered consumers, 1% answered employers, 4% payers, 2% health systems, and 67% answered all of the above.

[John L. Haughom]
Well, very interesting. Thank you. This is kind of a tricky question. I am definitely in the all of the above category. There’s no question that consumers are going to go to this. I’ll talk about that in January but there’s a number of surveys showing that consumers are eager actually to adapt to these technologies. I probably would say that employers would be a little higher up here. There are some peers already getting to this in a big way with very big payers and health systems for sure.

The point I want to make with this slide though is this. I think all of these entities will go down this road. But if you get ill or injured or a family member or a friend gets ill or injured, who do you think about? You don’t think about your employer. You don’t think about your payer. You think about your local doctor and hospital. So I think there’s going to be a natural pressure coming from consumers to say I want my doctor, I want my health system to help me use this data to help manage my health. So I think it will be consumer-driven and I think there’s no question the health system is going to have to get into this game.
Seizing the Opportunity

Okay. Ladies and gentlemen, what gives me tremendous confidence in the future is that the fact that we are now more empowered as individuals than in any time in the history of the world to take on the grand challenges of this planet, including healthcare’s challenges. As a result of exponential technology, we have amazing tools at our disposal and more are on the way. We have the passion to improve care and we have millions of new minds coming online to work with us to solve the grand challenges to do that, which we must do. We are moving into an extraordinary decade ahead. It is important that we recognize the opportunity and seize it.

In that regard, I love this quote by Mark Twain. “Twenty years from now, you will be more disappointed by the things that you did not do then by the things that you did do. So throw off the bowlines. Sail away from the safe harbor and catch the trade winds in your sails. Explore. Dream. And Discover.”

Thank you.
The first in a series of webinars on disruptive innovation in healthcare...

(wearable sensors, drug delivery systems, robotics, genomics, mobile computing technologies, social networking, remote patient management systems and telehealth)

Alright. Once again, I would just like to point out that this will be first in the series of webinars. I’m not exactly sure how many, probably another two or three, but they’ll focus on innovation in healthcare in various categories and also talk about the implications for analytics.
Thank You

Upcoming Educational Opportunities

There Is A 90% Probability That Your Son is Pregnant: Predicting the Future of Predictive Analytics in Healthcare

Date: December 17, 1-2pm, EST
Host: Dale Sanders, Senior Vice President, Health Catalyst
Register at http://healthcatalyst.com/

We always announce upcoming events and I’d like to announce another outstanding webinar by Dale Sanders focused on predictive analytics with the catchy title, There is a 90% Probability That Your Son Is Pregnant: Predicting the Future of Predictive Analytics in Healthcare.

So with that, I’ll turn it over to questions, Tyler.
## QUESTIONS

What categories of technology will impact healthcare and healthcare technology the most, in your opinion?

## ANSWERS

I think I would be hard-pressed to pick one, just one. I will say that I think the top ones that I can see here, particularly over the next five years will be the following – Genomics for sure because that is accelerating in a lot faster pace than most people actually realize. So I think that’s going to have huge implications five years from now. Sensors and wearable technologies, that will be very significant, and those are the first two, and I’ll do sensors and wearables in January and look at genomics in February.

Robotics is going to play a huge role in the future of healthcare and I think we’ll see that develop very very quickly. I will have a webinar focused on that because robots have been able to do things now that were unheard of and they’ll be assistants in the hospital and the outpatient world for patients at home. They’ll allow patients to remain independent and living longer. So I would say those are the three
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<td>In the level of data fragmentation in health continuum today and in pending arrival of sensor data and retail care, how do you see the data becoming reintegrated?</td>
<td>That’s an excellent question and very pertinent question. Healthcare has to get its house in order. The days when we could tolerate non-integrated data probably entered four or five years ago but they are certainly going to end over the next two or three years. We just can’t tolerate that anymore. As we move towards value, towards population health, you have to have integrated data in order to really manage the health of a population in order to really generate value. You can’t do it with a data that’s not integrated. And that has to be done before we start down the sensor world. So I think that most organizations are going to be on a pretty aggressive race to get their analytical houses in order, clean up their data, get it integrated in order to prepare themselves for those future reality. Remember the timelines we talked about in that one poll question. Now, you know, most of us think that a lot of this can happen over the next five years. So that basically means that if you’re going to get your data integrated as a precursor, you need to get it done over the next two or three years in anticipation of the next three to five years when all this is going to happen.</td>
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<td>If Medicare opens payment for any and all telemedicine services, will it have drastic impact on practitioners? Will the volumes go down for many? I guess they’re looking at telemedicine as a disruptive technology and if Medicare starts paying for that, how will that affect practitioners?</td>
<td>Again, a very good question. I will cover this in one of the future webinars. But the succinct answer to the question is this. If you look at the supply providers where there’s physicians, nurses, or other healthcare providers, we’re facing a massive looming shortage as a result of the immense growth and demand, a lot of it driven by things like baby boomers getting into their disease-producing ages, by millions of more people like Medicaid patients coming online and we’re not going to be able to deal with that level of volume with our current level of providers without using technology to extend the ability of providers to deal with it. I’ll tell you what my vision of the future is and I talk about this quite a lot, and that is we’re going to migrate. As we go to population management value, we’re going to migrate from an encounter-based model where each physician sees every patient in the ED, the clinic or the hospital, to a model where multidisciplinary teams led by physicians and nurses, including other care extenders, who instead of taking care of 2 or 3,000 patients like physicians do now, they’ll take care of 15 or 20,000 patients. And that is actually possible if you use these technologies because, as I’ll point out in future webinars, we</td>
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already know that they can help us see disease processes much earlier in their process, intervene earlier, benefit patients, and decrease the demand on providers.

So I don’t think providers have anything to worry about. They’re going to be, say, busy but I do think the work is going to get vastly more interesting and exciting and it won’t be destructive.

In order to do population management and achieve value for populations, there’s going to have to be an integration of provider entities. You can’t do it anywhere. You can’t go at risk for the population of a few million people unless you have a pretty integrated delivery structure. But it’s also true that you need that integrated data and the data itself is going to be valuable not only to those organizationally integrated systems but also beyond that.

Now, there’s a lot being written I know that’s pretty interesting about, I guess the whole privacy and security thing, and everybody agrees that HIPAA is a good thing. But as we accumulate all of these integrated data, there’s going to come a point when we have to make some decisions between how much do you protect individual security and privacy as opposed to making the data available so it can benefit society at either a regional, a state, or a national level. And those debates are already going on. If you Google that, you’ll find that there are people starting to question whether or not we have to refine our thinking around security and privacy. That was going to be a complicated area. It’s going to be dicey. It’s going to have a lot of emotion to it. But the integrated data ultimately is the main thing because it benefits not only the integrated delivery organization but it also can ultimately benefit society.

**How should enterprises today in the healthcare field prepare for the coming years of change?**

Wow. I could talk for about three days on that. It’s a very good question. I think you have to achieve the things that we’ve kind of touched on here throughout the presentation of the questions, and that is you needed an integrated delivery system, and that implies a lot of change and a lot of thinking about how to do it optimally and that’s happening as we speak across the country. You need to have the analytic infrastructure in place, a very robust analytic infrastructure. It has to include data from all sources, not just your electronic health records, but from operational system, financial systems, satisfaction...
It has to be all of the data there and very robust to deal with that.

But I would say the top thing that’s going to be the one that you really have to pay attention to really is the culture. The reality is we’ve got a culture that’s not ready for this in most parts of the country. There are a few that have kind of migrated towards it like Mayo or to some extent Kaiser. But in a lot of organizations, the culture is just not ready for all this and I think that starts with education. They have to see things like we saw on the presentation today. They have to see the world is going to change. And in my experience, once particularly providers can see that, they get excited, they embrace it, and that starts in itself. That education starts moving your culture. So I think culture will be huge.

Where does 3D printing and cell biology fit into your concept of the future?

Both are just fascinating and the implications for healthcare are huge. I’ll just use some examples with 3D printing. If you haven’t gone out there, Google 3D printing and then click on videos and you’ll see some amazing things. Just the other day, I saw one where there is a robot that was using molten steel to 3D print a very complicated structure. Molten steel. It was just fascinating. It was mesmerizing to watch. And the application in healthcare are going to be huge and is already happening. There has been skulls that have been 3-Dimensional reproduced for the top half of the patients’ skulls. They’ve been able in the lab to successfully reproduce a scaffold for certain organs using 3D printing, like the scaffold for a liver, and this is applicable to other organizations. We’re going to see joints 3D printed so that they exactly fit the patient. It’s amazing technology and it’s going to revolutionize healthcare in a huge way. Really really close off. I won’t kind of a lot of cell biology. We will be covering that going down the line. And by the way, the cell biology and the 3D printing were late. I just read a few days ago some work going on where they’re using 3D printing to create synthetic cells that could be useful in biology, health, and disease. A lot of these are interrelated like that. They feed on each other and it’s very exciting.

[Tyler Morgan]
Okay. Dr. Haughom, it looks like we’ve reached our time today. Thank you very much.

Before we close our webinar, we do have one last poll question. Our webinars are meant to be educational about various aspects affecting our industry, particularly from a data warehousing
and analytics perspective. We’ve had many requests, however, for more information about what Health Catalyst does and what our products are. If you are interested in a Health Catalyst introductory demo, please take the time to respond to this last poll question. And shortly after this webinar, you will receive an email with links to the recording of this webinar, the presentation slide, and the results of the poll question. Also, please look forward to the transcript notification we will send you once it is ready.

On behalf of Dr. Haughom, as well as the folks at Health Catalyst, I would like to thank you for joining us today. This webinar is now concluded.