Day 2 – 1 Daniel Kraft

10x Medical Device Conference

[00:00:00]

Daniel Kraft: Good morning, Minneapolis. Thank you, Joe, for having me and a pleasure and honor to be here. It's two hours before on the West Coast. It's still 6 a.m. but I had my caffeine, so I'm no longer hypocaffeinic. And what I think for the beginning of this on our starting off the day I want to help you think about is a bit of a re-imagination of where health medicine and medical devices can go and through sort of the convergence of many fast-moving technologies. And I think before we sort of look into the future it's sometimes good to go back to the future, and I had a chance to do that a couple of years ago. I did my residency in Boston after medical school at Stanford and at the Massachusetts General Hospital, which is a famed old medical institution here in the US. We had our 200th anniversary at MGH, so I had a chance to reunite with the house staff that I trained with. I'm there in the middle. It's before those 80-hour work week restrictions, so we were real residents, and of course being in Boston we could joke about walking uphill both ways in the snow.

And I found myself after one of the receptions in the old building, the Bulfinch Building and one of the most famous spots of healthcare history let alone US healthcare history. And you might recognize that building at the top, that room at the top called the Ether Dome, and it's called the Ether Dome because in 1846 this patient, pictured in this actual picture, was the first patient to get general anesthesia with his surgery. Before that, they literally bite the bullet. This picture is clearly before HIPAA laws. And if you go back to the Ether Dome today, it's pretty much like it was in 1846, frozen in time. The actual Ether sponge is in the case, the actual instruments from the case are in the back of the room, frozen in time, a bit of a shrine to medical history.

Another shrine in medical history I discovered to my dismay was about four minutes down the hall where I spent my first month as a brand new intern in 1996, and that was also frozen in time, pretty much the same exact place, same alarms beeping, some same nurses, some same patients. I had a little PTSD I think when I walked in there. Literally unchanged except for the fact that the young intern who was on call was pushing around like a 10-year-old laptop, had to type out the electronic record, print it out, put it in a paper chart, and they're still using the fax machine, the height of medical device technology, to communicate to the pharmacy two floors below. And I'm thinking, "You know, this is men's greatest

hospital, women's greatest hospital too." And it's still based on the 1846 structures, based on old silos of how healthcare has been defined, departments, specialties, fiefdoms. Particularly we see that in academics and in companies and beyond.

And we're in this new era of connected and digital health and genomics and beyond, and I think we can just think beyond waiting the three hours for the 30-minute visit or 10-minute visit in the waiting room or we can think beyond defining healthcare by its old silos of body parts and specialties. And what I challenge you to do and what we'll talk about this morning and I think many other speakers—some of them are good friends of mine—will touch upon is how we might rethink and reinvent medicine and devices as an integral part of that as we go downstream. And we're going to need to rethink and reinvent healthcare if we're going to address the huge challenges we have, whether it's the 18% or 19% of our GDP, the aging demographic with Obamacare, many more covered Americans but a huge shortage of primary care physicians and specialists in most parts of the country and the world. We practice medicine differently at Stanford versus MGH, why is that? And we're in this big data era, but how do we make that big data, big information, actual information that we can use at the point of care and take maybe the I think roughly 30% of healthcare dollars which are sort of wasted in filling out triplicate forms for the third time asking you about your fractured arm when you were 3 to hopefully make healthcare more efficient?

And I think while many of the technologies many of you are working on and I'll discuss in this talk are here, we also have the challenges of our friends at the FDA, and there'll be a nice discussion about that later, who often don't always understand the pace of technology and how we might rethink even clinical trials; and also, our friends, the payors, without whom many of these things wouldn't get into the clinic. So, many challenges along the way.

Two frame shifts to think about before we dive in to the technology side is, how do we practice healthcare today? In fact, we don't practice healthcare, we practice sick care. We're incentivized as clinicians and healthcare systems and device manufacturers to treat the chronically ill or acutely ill on the right side of the equation. That's why in many parts of the country we even spent 50% of our cost on even 5% of the population, and that's because we practice incentive-based medicine not necessarily reimbursement-based medicine as opposed to evidence-based medicine. And that is starting to shift with some of the reimbursements and others going to value-based and outcome-based care on the left side, and technology and devices can play a big role on that.

Another meta shift is, where is healthcare happening? They're traditionally in the hospital ICU clinic, but now more and more of the pressures are to keep folks out of the hospital or discharge them more quickly, and the new layering of technology and analytics and devices and others that are coming to our bodies in our homes are really shifting that as well. So, where healthcare is practiced. And of course, the vocabulary with that is shifting from just fee for service and being rewarded by seeing more patients to outcome- and value-based elements, and that's going to be translated to how we pay for drugs and devices downstream. So, the mores are changing and there's a bit of a perfect storm hopefully brewing to shift things dramatically in healthcare.

So I came back to Stanford for fellowships in hematology, oncology and bone marrow transplantation about 10 years ago, and if you think about how much has the world changed even the last 10 years, I don't know if any of you saw the Steve Jobs movie, in the opening scene he's waving around the magic first iPod, a thousand songs in your pocket, and I was shocked that that was 2001. That was the year I started fellowship. And that's [00:05:51] progress quickly and it seems much longer in some ways than 2001, but the iPod, which now has 10x more songs and is half the price, is an example of technology moving what I'll call exponentially. We tend to think linearly, our minds. Thirty linear steps I'll be to the door, 30 exponential steps doubling 2 , 4, 8, 16, 32. By 15 steps I'll be at 30,000, and at 30 steps, we don't often get that in our minds, will be a billion steps. That's 26 times around the planet.

And it's where exponential technologies are happening that I think we have the opportunity to disrupt elements of health and medicine and leverage the technology role of devices in that particularly as well. And the trick for us who often think linearly is to go, "Where is the puck going on this exponential path?" Like Wayne Gretsky says, "You want to go to where the puck is going to be." So if you're building a new device technology or platform, you don't want to build that with 2014 technology. You want to think about what will be here in 2016 or 2020, because just like Moore's Law things are appreciating quicker and quicker. That's why with Moore's law and computation, our smartphones had about a billion times the price and speed of the best supercomputers in the seventies. Your iPad's about as powerful as a Cray supercomputer in the early eighties. And it's not just Moore's Law that's moving exponentially, it's many technologies, and it's when they mash up with their convergence, you know, 3D printing, big data, AI, robotics, Internet [00:07:18] that things get really interesting, and I think particularly in the device world enable us to do some pretty magical innovations and reinventions.

So just to think about what's happened even in the last again decade that's being reinvented, we now sell more e-books than regular books, at least Amazon does. They've disrupted themselves in terms of their model. Blockbuster's gone bust with the emergence of faster and faster streaming. We've seen the emergence of new ways to pay for things that's changing the popup store model and how we buy things. I'm not sure [00:07:52] into an actual real travel agency, that's changed dramatically.

Anyone here use Uber? Uber is a magical little app, right? They didn't reinvent any technology for that. The company didn't, right? They didn't invent mobile or maps or online payments or social networks or GPS. They just laid it up in a smart way and makes it kind of fun to travel in some ways. They even have it here. Those are like two cars [00:08:15] **I could see on the map yet**, but it's coming to Minneapolis. And what would the Uber healthcare be? Will you change some of the efficiencies and make it more engaging and empowering?

And just as an example of how fast the world is moving, this is the...inauguration of the Pope in 2005 and the next Pope in 2013. Same exact scene, but you can see the difference and the technology difference in only about eight years and it exemplifies the path of disruption. Kodak had its Kodak moment. They actually invented digital photography. They own the patents, but they didn't pay attention to the exponential trends in the early few-pixel cameras. [00:08:51] **And not so** big deal, we're not going to go into that, but they didn't pay attention to the pace and what happened about a year or so ago, they were bankrupt, and Instagram, 12 kids down the street from [00:08:59] **me in Palo Alto**, sold for a billion dollars, which is even like chump change these days in some markets. So you don't want to be a Kodak or a Blockbuster or RIM, and the trick is to think about, where can you self-disrupt or how will you be disrupted by others moving forward so that we don't have some of the challenges let's say that the farm industry is having today as drugs go off patent and beyond?

Okay, so let's look at a few exponentials that are happening in healthcare today. You're all aware of the human genome. It was only sequenced essentially 10 or 12 years ago. The first ones took years, billions of dollars, but the price of sequencing and the speed of sequencing your own personal genome has dropped at twice the rate of Moore's law to the point where today, with Alumina-based technologies, about a thousand dollars it could be done in about eight hours, will soon probably be at a 100-dollar genome, and there are really interesting implications including for the device world about understanding new patients' genome or fractions of your genome. You can spit in a tube today and drop it in the mail with 23andMe, there'll be some FDA issues, but for 99 dollars literally get 1. 6 million base pairs, SNPs, analyzed, which has huge potential for

pharmacogenomics, for at least helping categorize risks in a variety of patients and ways. There are USP-based genetic analyzers that will do point of care, pharmacogenomics.

Here's my colleague from Singularity University, Raymond who brought to me…I prescribed him his genome and he brought it to me on a disc drive. So if he was my patient, what do you do when patient presents with genome? We still don't quite yet know what to do with these massive amounts of data. We'll hear more from Marty Kohn and others about some of the elements of AI and analytics, but the challenge will be to take that information and make it actionable, because it's not just genomics that's moving exponentially. We have low-cost [00:10:42] coming, tens of thousands of biomarkers from your blood, the environment [00:10:46] **exposal,** where you've lived and what you've been exposed to which could be picked by our mobile phones and beyond. Biomarker data, the microbiome, and there's now kits, 100 dollars you could sequence your microbiome, which is going to play an important role in inflammatory bowel disease and obesity and other elements. Lots happening along those realms and it's beyond personalized medicine or precision medicine now. I think it's best exemplified by Dr. Lee Hood, the founder of [00:11:11] **systems health medicine**. He calls it P4 medicine. Predictive, you'll be sequenced maybe even at birth, and you can all watch the movie Gattaca to get some of the ethical implications there. When you have your predictive genetic analysis, [00:11:25] **preventative** and take certain steps like taking aspirin for heart disease, and that can be personalized because not everybody, one in three Caucasians at least don't benefit from aspirin based on their genetics. And the final P, which I think is really getting interesting today, is participatory. We can start to crowdsource and share our data in powerful new ways to make healthcare faster and smarter.

So with exponential speed, again, we can do some amazing things with computation, with imaging to reconstruct on your tablet that used to take hours or days of calculation time to do a better job of where do you put that medical device or intervention or otherwise and avoid the blood vessel and target the tumor, for example. We'll see a disruption coming in the world of neuroscience, from neural pacemakers and beyond with not only the ability to understand the anatomy in high resolution but the incredible connect dome which is being mapped. So new ways of understanding the brain and neuroscience, all the way now to my colleague at Stanford, Karl Deisseroth, making brains in sort of invisible for understanding the structure and connectivity, which will hopefully play a role in enabling earlier diagnosis of diseases like Alzheimer's, which with this technology a little you can pick up 10 or 20 years before clinical science will pop up. Or what if you could use this new modality for a company called Neurotrack

just using eye tracking to diagnose Alzheimer's 10 years early before it has clinical science? So maybe we could treat it with some of those drugs that don't work well in advanced stages. There is now blood testing involved as well.

Cardiology—a lot of you are in the cardiac device base—is going to change dramatically and disrupt, for example, the interventional cardiologist. The cardiac angiogram you know well I think will be disrupted by a company called HeartFlow out of Stanford where they can do a 30-second CT scan of your heart, reconstruct that data in the cloud and compute with the FFR, fractional flow reserve. In this case, this is real patient data. We can see that there's a narrowing that can be calculated as well as with a catheter-based approach, and now you can determine, does that patient need a stent or a bypass? What kind of stent? Maybe with 3D print a stent exactly for the patient's anatomy. So I think that realm will be disrupted shortly. They're in advanced clinical trials in New York and elsewhere.

A company I advise out of Stanford called Morpheus can do a 10-minute cardiac MRI, completely reconstruct the heart and its function, which I think will disrupt echo pretty soon, and that information comes back to your tablet 10 minutes later. So lots of ways of blending convergence of higher speed imaging, cloud-based computing and beyond to rethink diagnostics, for example.

Now, one technology that's shifting healthcare for all of us is mobile, right? When I started fellowship I think I had the advanced PalmPilot, and now clearly we're in the mobile and tablet age, and if you think about it has only been four years literally, four years, I think in May that the iPad came out, and now it's bring your own device to work whether your IT Department wants it or not. And these technologies are getting smaller and cheaper. I have in my pocket the world's cheapest Android tablet. I think it's sold in India right now. Anyone want to guess what the price is of the lowest-priced tablet on the market? Twenty-five? Twenty? Come on. Alright, 35 dollars. Okay, here, it's disposable. Next year's 25, right? Now it's not the world's fastest Android but for 25 bucks this one's really crap so it's disposable. You could give this away for less than the price of an x-ray or a prescription and it's going to have a lot of implications from public health to augmenting nurse practitioners in a rural village or for clinical trials where you can just give this to your patients, preload it with their Angry Birds and their clinical trial interactivity. So, think about what you can do with a 35-dollar tablet in your next stages of whatever you're doing.

And with mobile, what I think these do is provide a feedback loop of data whether you're diabetic and now you can record your blood sugars directly onto your smartphone or tablet, have a dashboard for that data to help you understand it and

tweak whether it's your insulin or your oral meds. You don't even need to have a connected app or glucometer. This app was developed to incentivize type 2 diabetics to record their blood sugars on the smartphone, send it to the primary care doc who is also incentivized to then optimize their meds, and they dropped hemoglobin A1c's by 2 percentage points, which is huge if you know hemoglobin A1c's. It's better than any blockbuster drug. So when will we be at the point where we'll really start prescribing apps with our drugs and devices whether that's for positive things like pregnancy or for pre- and postop or beyond?

And we're taking sensibilities from I think many of you have probably used OpenTable for making reservations at restaurants. One of the most successful healthcare IT companies called ZocDoc has done OpenTable for doctor visits, and so now you can literally find the surgeon down the street, go, "Is a visit open that day?" if you need it when there might've been a cancellation, and make things much smoother and more efficient.

Actually, myself used this about three months ago. I had a funny little lump on my neck for years. I knew it was benign but I wasn't sure exactly what it was, so I downloaded this app called i-DERM, took a picture of my lesions, sent it in, a dermatologist came back 12 minutes later and gave me a likely diagnosis. I found a plastic surgeon with good ratings down the street, had an appointment two days later, sent another picture, did the whole appointment on my smartphone including all the little forms, went in the very first time and no preop visit, just did the procedure, "here's the case, there's the cyst, da da da, pathology, things good, the scar you can see is getting better." And that was all done on a mobile device with one visit and avoiding the preop and the diagnostic visit and beyond. So a lot of sensibilities are coming and I think you can blend that in in how you manage use of devices and software beyond and make healthcare more engaging. The new drug is the empowered patient, whether they're playing games to stay on top of their medical compliance or, as we develop at Stanford, a game for our cancer patients to shoot their tumor and raise their white counts for our pediatric oncology patients, or to take off-the-shelf technologies like Xbox to make things like physical therapy more engaging, right? Most folks are terrible doing PT, but now you can measure and make it very super-accurate, and that's not even new technology now. That's been hacked in the operating room to move images with your fingers. That technology has already been disrupted by a company called Leap Motion, which can do magical things of following every single finger in your hand, and you can imagine some of these as you might have for interventionists or patients or PT or beyond. So we're moving to this era of engaged empowered healthcare. And it's also been termed as the era of mobile health or digital or connected health, and it's not of course just the vital signs and

electronic medical records are being digitized, it's all this technology that can come from our smart pockets and our smart diagnostics, which are at this stage approaching clinical [00:17:55] gray, whether it's eye diagnostics from MIT's EyeNetra that can do basic eye exams and is being piloted in India where there's very few optometrists to the clinical otoscope connectivity that's on the lower right from a company called CellScope. So I can just attach this little smartphone connectivity to do ear exams if you have young kids or if you're a pediatrician and get a good imagery there.

My friend Dr. Dave Albert, one of the, I think, pioneers of mobile health, developed the Alive-Cor EKG. If you haven't seen this device, you can try it later. We can pass it around and see here who has heart block or other diagnosis. So just an EKG right on my smartphone, and what's really interesting about this, they were really the pioneers in getting this FDA-approved, and first it was sold with a physician prescription but as of February it's now over-the-counter. And now they've actually added functionality – if you don't read EKGs, well, you can press a button and have your EKG from your phone read by a cardiologist or a less expensive route and get your data right back on your phone a few minutes later. So lots of ways to use this for diagnostics, for managing devices, drugs, conditions, like afib and beyond. So think about what you could do with that in a variety of realms. This is not science fiction. It's here today.

And a lot of this new kind of mobile and connected health has been spurred by this new movement out of the Bay Area originally called the Quantified Self, which I think is moving to Quantified Health. It's not just tracking our steps. How many people here wear Fitbit or anything like that? A few of you, tried it, right. I'm wearing like four different versions right now, you know, in case I'm confused. And these are starting with, as you know, quantified self-devices [00:19:30] be tracking your basic activity, but they're moving to much more Quantified Self 3.0. I'm wearing the Basis watch which not only tells time, it tracks my steps, my calories, and my heart rate. It has a little heart rate sensor at the bottom, and interestingly they just, and here's the sort of the data, it doesn't show too well, but this could be used, for example, patients who are on a beta-blocker or other meds to track their activity, and interestingly they just sold to Intel for 110 million dollars a couple of months ago. So the watch space and the way you can put healthcare on your wrist is going to be very interesting, and of course…I have a picture somewhere. I used to have a picture here of the rumored iWatch coming out. So watch the watch space, and Apple and others are getting into that.

A lot of these technologies will just appear into our phones. You can already with the new chip on the iPhone do basic analytics, but that's going to be very, very

powerful. So Quantified Self is counting everything from our forks—this is called the HAPIfork to track your eating, that's how happy you are if you use it—to much more sort of mundane elements of healthcare like blood pressure, but we know that one in three Americans has hypertension but less than half of them have it well-controlled, and now you can have, I've got one in my bag, connected blood pressure cuffs sold in an Apple store or Best Buy. And with that, you can get a dashboard to your data and hopefully improve moderation of hypertension in a much more smart feedback looped way. Or for patients with asthma, a company developing something called the Wheezometer. This is to track and objectively measure wheezing. And once you know if your kid is wheezing where they are in the track, a company called Propeller Health has developed a GPS device to go on your rescue inhaler to know where and when your patients or your whole panel of patients have used their inhalers. So lots of ways to think about leveraging both devices and data and mapping to make healthcare hopefully smarter as well.

And these things again are shrinking. There are digital tattoos being developed. I'm actually wearing right now a patch from a relatively new company in the Bay Area called Vital Connect. It's a two-dollar disposable patch and will be in the market this year. I'm actually wearing it live. Let's see if the data is working, and here you can, hopefully, see my live data stream. My heart rate is 93. I'm only 91% stressed. Thanks, Joe. You can see how many steps I'm doing. If I fall down, there's a little posture marker which is off, and if I don't get up I could call my mom or 911. It should show my EKG here eventually. Right now it's streaming to my smartphone. And imagine, this could be logged into by anyone on the planet right now who had my login and that could be useful in trial development with folks being discharged from the hospital and beyond. So lots of ways to see that data. Here's the EKG which is not showing up there yet but it's on my phone. It's hands-free. Look, no hands, mom. So, think about what might be able to do with this type of technology as this gets better in the future. Alright.

And of course we're moving from the world of wearables to insidables. This is the magical conversion technology, the iPill, swallowable pill to replace upper endoscopies in some cases. And so a lot of these things are going to be blending and providing us really interesting data sense. The trick again is, what do we do with it? How do we put it all together?

And the clinicians of today and the near future will have digital doctor bags, mostly components of medical devices that used to again be things you'd have to go to the clinic or the ICU to have. The challenge is how do you put that together to make it standardized, talk to each other, storable, because there are so many of these devices emerging both consumer and some that are being FDA-approved that there's also often a challenge of, which one do you get? And I founded a

company last fall called Bionichealth, and one of the things we're doing is creating basically an online platform to see all the connected digital health tools, apps and services that are available today, allow you to compare them, pull the data in as a patient sort of like LinkedIn or Mint.com for your health, and we're providing a platform for physicians to prescribe connected health devices. I could say, "Joe, I want to prescribe you exercise and I want to see how you're doing and get that data back into my electronic medical record."

Joe Hage: You'd be disappointed.

Daniel Kraft: Yeah, okay. Well, 10,000 steps a day at least, I expect. It's not just of course vital sign data. Now that [00:23:46] **we're of** low-cost microfluidics, that can be the point of care to do blood analysis whether that's in remote villages for global health, and you'll hear from Dr. Eric Rasmussen later, for maybe diagnosing malaria and which type of malaria and what drug to use all the way to the new emergence of, it's hard to see here, I think, but technologies that can do simple things like urinalysis.

This is from a company called Scanadu. It's in FDA process right now. Dip the urine dipstick, take a picture with the app in the smartphone, and get a very quantified urinalysis back right away. Or, for testing viral infections, spit in the tube. There's the basic pregnancy test on the car, take a picture with the app, and it collects the data, sends it to your doc and maybe the CDC as well so you can crowdsource that data. So, these are all being developed and they're going to change the way we do diagnostics.

And the metatheme here is this idea of a digital checkup from anywhere, right? Anywhere in the planet we can almost have first-world medicine elements with both the vital sign element, the lab element and, increasingly, telemedicine. I think within five years 50% of visits may be mediated by telemedicine because not every visit requires hands-on, and I think this could be a powerful way to help run trials, modulate patients and beyond, and keep folks happier and healthier at home in a variety of ways. Okay.

And again, when you're thinking about this, particularly in the device world, it's the layering of these technologies, not any one piece, and a lot of these elements can come together in more and more powerful ways. When they do come together, like our friends from Medtronic with their new versions of their smaller pacemaker, there are interesting other challenges because now these pacemakers have IP addresses. They talk to apps. You may have heard that Dick Cheney turned off the connectivity of his pacemaker. He was afraid it might've gotten hacked. That might've been a good thing, but imagine what happens when

someone hacks your pacemaker or your insulin pump or steals your DNA and publishes it on the web if you're running for president or vice president. So lots of interesting implications there, as well as another I think Minnesota-based company that had some challenges when my friend Hugo, who's got cardiomyopathy, has an implantable AICD, wouldn't give him his own data from his device. Who owns the data from these devices in your own bodies? Is it just the device company? Can the patient have access to it, I mean, the actual raw data? And interestingly enough, Hugo got rights to his data once the CEO of this company tweeted how much he liked his FitBit data on Twitter and they had a Twitter war and the data emerged, power social media. Now, with all this digital, mobile health, connected health, you know, our brains, these clinicians or other folks in the healthcare [00:26:19], will have [00:26:20] **improved in** or been upgraded in 1.5 million years or so, but the complexity of healthcare is getting dramatically more challenging and that's where I think we're going to need new tools to enable us, wherever part of healthcare we're in. And we're going to hear later this morning from my friend Marty Kohn who used to be with IBM Watson, and if any of you saw Watson beat the pants off the special, the two champions in jeopardy a couple years ago. [00:26:49]

[Video plays]

Kathleen Kenyon's excavation of this city mentioned in Joshua showed the walls had been repaired 17 times. Watson.

Watson: What is Jericho.

Correct.

Watson: 400, same category.

This mystery author and her archeologist hubby dug in hopes of finding the lost Syrian city of Arkesh. Watson.

Watson: Who is Agatha Christie?

Correct. Watson.

Watson: Who is Mary Leakey?

You're right. Watson.

Watson: What is Crete?

Yes.

Watson: Let's finish. Chicks dig me.

[Video Ends]

You get the idea. It didn't just beat those guys, it spanked them, right? And as you'll hear from Marty a bit soon, the idea is not to replace doctors with AI but to augment them, so I like to call it not AI but IA, intelligence augmentation. And we're going to see I think AI across the spectrum of healthcare in many ways which I'll let Dr. Kohn speak more to next. Now, with these blended sensibilities, we can do some really interesting things. I'm sure we have some Trekkies here. We have the elements of Star Trek [00:27:53] already in our pocket now with medical devices, small ultrasound devices. We're seeing the evolution of X Prize. I was involved in the X Prize to design a medical tricorder. It's a competition sponsored now by Qualcomm, $10 million to blend essentially a medical device for the consumer at the home to do diagnostics. And one of the companies that emerged out of the first FutureMed program that I founded three years ago now is a company called Scanadu, and they're basically one of the leading companies in this realm, are developing a little [00:28:20] tricorder. I've got one of the prototypes right here. Hold this in your forehead and you get your heart rate, respiratory rate, temperature, pulse ox, stress levels, etc., and it's going to I believe now connect to Watson through your smartphone. They're calling it Holmes in that realm, and this is what the version that is shipping next month as part of their FDA trial looks like. And what's really interesting about this, they thought about design very carefully. And I actually introduced this company to the famous design firm IDO to think about how might this fit into the clinical infrastructure in the next two years, and we made this little video, a vignette of what some of these blended device information technologies will look like in the next few years. Take a quick look.

[Video Plays]

Technology has given us an unprecedented window into the human body, but on a day-to-day basis, we're still in the dark about our own health. We are changing that. What if instead of fearing the worst when you notice something out of the ordinary, you could identify the condition yourself? Getting the right diagnosis would save you worry and an unnecessary doctor's visit. Instead of hearing about a viral outbreak on the news, imagine you got an alert that was tailored to your family's needs. It would also give you advice about what to do next. What if you had a way to identify what was wrong right away, a way to get all of the information you need to understand the situation? And in serious cases, you would know when and where to seek help. We're building a way for people to

check their bodies as often as they check their email. It's all possible and it's only the beginning.

[Video Ends]

Daniel Kraft: I saw you checking email in the back. The average American checks email like 150 times a day, so the hypochondriacs of us are trouble, but this is again not science fiction. What's really interesting is they actually crowdfunded the medical trial on this, 10,000 of these devices, they broke the record [00:30:46] I think at 1.6 million dollars. So when you're starting a new device company, you might want to think about the crowdfunding implications for taking this forward. And they're doing this trial in the collaboration with the FDA, who wants these tricorder technologies to get out there once they've proven themselves in the field.

So, of course, with all these data devices and Scanadu devices, the challenge will be, you know, how do we make sense of this? And I think putting it together in a good form is going to be particularly important. My favorite analogy for that would be the modern car, which has 200-plus sensors in it. You don't care about any of the individual sensors. You care about when your check engine light comes on. So think about the OnStar of the body. These integration…the Internet of things can be the Internet of body, the Google now of healthcare, which I think will emerge from these disparate sources of information coming downstream in the near future. And that enables us to have much more smart connected health. It's not just…again, we don't live in individual silos. Our social networks are incredibly important to our healthcare for understanding obesity, the heart disease, the depression. We know that our behaviors are more important than our genetics in terms of our outcomes downstream.

So we can start to…in fact, our new interventions like prescribing behavior change, a company called Moda Health is doing that for pre-diabetics, folks that are on the cusp of becoming diabetics, puts them into a social network, gives them a connected scale wearable device, and they dramatically turn folks around. So who's going to pay for that and regulate that kind of technology? We can help rewire our brains for behavior change, this idea of an augmented future you mirror where you see yourself in the mirror after you've done your P90X workouts or if you keep having Danishes and donuts for breakfast. Joe, we had donuts for breakfast. This is a healthcare conference. Alright. So if you had donuts for breakfast, this might happen. Now, they were good donuts. I had one. Sorry. But if I kept having donuts for breakfast, I might get a little warning about what I might start to look like, right? So there are these sensibilities that are out there today whether you want to show a smoker what she's going to look like in 10 years at two packs a day or if your kid spends too much time on Facebook. So,

lots of ways to start blending these sensibilities as we go downstream. Oculus Rift, just bought by Facebook, will be an interesting platform for this as well.

Another realm that's getting interesting is telepresence, and telemedicine is being enabled by robotics from this fancy version, which enables you to round in the hospital and see patients at a very high fidelity to low-cost versions which are now approaching a thousand dollars. There's one built by our students at Singularity University, and in fact I'm going to give a quick demo here. This is the beam robot, we had this at the last FutureMed, where now you can beam into a robot almost anywhere. This is the innovation lab at Singularity UM now driving around the robot live, and if there is someone that would talk to me at now 7 in the morning there, I could see them. Those are what the other beam robots look like right there. So lots of ways to now interact and change how you might interact with your colleagues around the planet or beyond. So I'll doc that away. But telepresence is getting really, really interesting. There are lots of interesting healthcare implications. Okay.

Robotics are helping the disabled in a variety of ways, everything from the amazing world now of brain computer interface, chips on the brain to enable the folks who are quadriplegic to control robotic limbs. This is from my old roommate at Brown University, led this trial. So this woman can now give herself her first drink in 16 years. She's quadriplegic. We're seeing brain computer interface play a role in other interventions from controlling games to letting kids with ADHD focus better and learn to get off their Ritalin. We're seeing the evolution of wearable robotics, exoskeletons, which are certainly a form of medical device. A company called Ekso Bionics out of Berkley has developed this for the paralyzed, which is moving really quickly to this… For example, this woman, she's wearing eLegs device, she's paralyzed from the waist down from a ski accident, and parts of that are 3D printed [00:34:30] anatomy. So, the blending of those sensibilities. If you have seen the talk from Hugh Herr at MIT, you can see the advanced prosthetics to enable this woman who lost her leg in the Boston Marathon to dance again. The challenge is CMS is not giving reimbursement codes enough to allow this company to survive, so obviously the [00:34:47] element is really critical despite the [00:34:50].

Now, of course, we don't want to just treat spinal cord injury, we want to cure it. I came from the regenerative medicine world. I spent 10 years in the lab at Stanford. In that realm, we're now in the world of induced pluripotent stem cells to build your own bucket of body parts. We're moving that into the realm of 3D printing, which certainly is impacting device worlds where you can start to print body parts, prosthetics, molds, elements for orthopedics. I can print a 3D version of me. That might be useful if, for example, I have a patient who lost part of their

face from cancer to make a prosthetic. We're blending that with bionics and beyond. So, lots of ways to have these sensibilities come forward to the point where we will be eventually I think 3D printing more complex organs downstream.

On the stem cell world, a device technology I developed as a fellow at Stanford for the Stanford biodesign program was the challenge of harvesting bone marrow. I had to do a couple hours a week in the OR pulling out marrows. I thought, "This is kind of silly. Why a hundred holes in someone's back in general anesthesia?" So I invented the device called the marrow miner, a flexible Roto-Rooter type device. You can go in one puncture, pull out instead a liter bone marrow about 300 ml of marrow in 10 minutes with more stem cells than you'd have in a standard approach, and this is after FDA approval and CE mark we did our first clinical trial. You can see in a live patient the device moving through the curve of the iliac bone and pulling out marrow. And marrow is being used not just in bone marrow transplant in my clinical field but in a variety of regenerative fields using stem cells for cardiovascular disease, critical limb ischemia, orthopedics, and beyond. So if any of you are in that world and want to collaborate with this technology, we've now just developed a gen 2 device and hope to start selling it later this year. Okay, I've got to speed up because we're short on time exponentially. How much time do I have left?

Joe Hage: Good news and bad news is that our speaker who's flying in from Israel is flying into O'Hare and enjoying thunderstorms right now.

Daniel Kraft: Okay.

Joe Hage: So we have a little extra time and I'm sure you're going to have some questions. So take another 5 maybe in the prepared remarks.

Daniel Kraft: Perfect. Alright, good. Thanks. So why I'm speaking to you as a bone marrow transplant pediatric oncologist about technology? Well, about five years ago I was on the founding faculty of a new institution called Singularity University based at the heart of Silicon Valley at NASA Ames. Whose heard of Singularity University here? A few of you? Okay. For those of you who haven't, it's not about the singularity exactly but it's about understanding technologies along different arenas from medicine, biotech, robotics, AI, 3D printing, and beyond. It was cofounded by Ray Kurzweil, a famous inventor and futurist, now the head of engineering at Google, and Peter Diamandis, the physician who started the X Prize. And we look at where technology is heading and how we can leverage that to impact global health, poverty, education, and healthcare. And some really interesting healthcare innovations have come out from student projects and others.

We have 10-week programs in the summer and one-week executive programs. This team is developing drones for delivering drugs and vaccines and devices in parts of the world which are difficult to access. They [00:37:45] this already in Haiti, for example, for delivering medical packages. This is well before Amazon was in the news for delivering your pizza. And that's just one example. Another team last summer developed ways to take Blu-ray Discs and make them into laboratory platforms. Our medical student team developed a glove with integrated diagnostics on the fingertips for doing self-exams or augmented telemedicine exams.

And because everyone who came to Singularity University was interested in healthcare to some degree whether personally or through their other realms, three years ago I put together an executive program called FutureMed, which Joe came to last fall. And what's pretty amazing about FutureMed, it's not siloed in just oncology or cardiology or devices. We're about half physicians. The other half are everyone from across spectrum, from pharma to devices to app makers to folks who are investors. We've had so much demand for the program. We grew it. It's now being called exponential medicine. We had the last one in the fall at the Hotel del Coronado in sunny San Diego in November. It's warm there. Then, this is everybody on the green wearing their scrubs. And some really magical new collaborations and insights have come out of that program from Scanadu, the medical tricorder company, to Jointly, which we'll hear about shortly. And I encourage you to come join us in November. We'll send you all [00:39:03] code, 10X, to come to that exponentialmedicine.com. And part of the theme of Exponential Medicine is that no one player is really the innovator now. It's the convergence of all these interesting players from design thinking to robotics to AI to big data. There's a whole new set of accelerators and incubators that have been [00:39:21] **borne up**. There are new designers coming into the space because you can't just build a technology [00:39:25] **and use** to work within context whether you're trying to reinvent a cane or beyond.

And I like to take the lessons from other fields like flying. I've been a pilot since college. Here's a picture of me I think in my first airplane, a Cessna 150. And then later, when I was a resident at Mass General, I joined the international guard as a flight surgeon. And [00:39:45] **I wasn't the** fighter pilot but I get to fly with to take care of the fighter pilots both in F-15s and S-16s. And there are lessons we can take from the aviation world that we can apply to healthcare in the device world. For example, checklists which have made flying safer are making the OR safer. Those have been the checklist manifesto technologies [00:40:01] **flight** across healthcare including for emergency procedures, and now those are being amplified and more personalized. We're seeing lessons from the world of

simulation. Flying has gotten a lot safer, and now we're taking the sensibilities of training pilots to training surgeons and medical students and nurses not just on individual procedures but on bringing them together when they come into a trauma room or a code room. This is our sim center at Stanford. And so the old motif of "see one, do one, teach one" is shifting to "see one, sim one, sim one, sim one until you get it right." And it's also blending how we design drugs, devices and pharma. You can predict which drugs are going to work by modeling them. We're seeing the evolution of labs on a chip, sort of micro devices that are micro organs for doing **pre-phase** [00:40:43] trials. So, lots of integration in the simulation world. One more example would be the heads-up display in the cockpit, the round dials of the glass cockpit…or the steamed gauges have turned into the glass cockpit. This is the U-2 spy plane before and after being converted over and, you know, how do we manage this data as a pilot to give us situational awareness whether a patient or a physician or a caregiver? And we use heads-up display in the fighter pilot world. We need different data for flying in bad weather or about to hit a mountain. Sometimes Bitching Bob or Bitching Betty comes to talk to us before we hit the mountain, [00:41:18] **tells us to pull up**.

Voice: Altitude, altitude, altitude.

Daniel Kraft: And we need different data if we're in a dog fight and someone's on our tail. So how do you take the information and make it smart and accessible at the right time, just like we had with our new cars, which can often gives us feedback loops or [00:41:33]? And we can see that affect behavior and performance in a variety of ways. So the trick will be, how do we build GPSs for our health, whether it's an individual patient to say, you know, Daniel, take a right and go to the gym and not left at the McDonald's, right? And how do we frame that information so it's applicable to that patient in the form factor that makes sense to them without being overwhelmed, right? So we need to have the smart design thinking there.

And a lot of this data is going to start coming to us in new ways, whether it's assisted living contact lenses, which are being developed to give us Internet right from our contacts, which has a dark side as well, to the new evolution of Google Glass, which we had the head of Google Glass come to FutureMed last February. And this platform is already being heavily innovated upon to impact healthcare, everything from what physicians use from the electronic medical record to enabling the surgeon to see vital sign data instead of having to pull their head out of the case or checklist in the operating room, for patients to track their med compliance. I think healthcares are very great use case, not to wear these all the time but when you need to have your hands free in a variety of realms. And maybe, when you look at your donut or breakfast in the morning in the near

future, you'll see it this way now, but soon you'll see it differently and you'll have other cues before you have your donut for breakfast, you know.

Voice: Pull up, pull up.

Daniel Kraft: The last example will be radar. What if you knew where all the patients with your device implanted were on the planet and how they were doing or how different ones with different genotypes or other comorbidities were doing? Where are the thunderstorms with that device on its clinical trial [00:43:04] post marketing? What if we can start to share the sensibility and the crowdsourcing just like with Google Maps, in ways you share a little privacy and your location speed when you're driving, but now you can build a map. In this case, you can build a map of Rome [00:43:17] **in a** day based on just driver information. So what if we could use that same sensibility as data donors in healthcare in smart ways that are HIPAA compliant as well as we go downstream?

So in closing, I think in my experience as a clinician and researcher, in many ways in healthcare it has been very empiric. We've been sort of flying blind, but now we have a whole new set of tools and data coming at us which can enable us to be empowered as clinicians, as device manufacturers and innovators. We can take this data in new ways whether from our social networks to create bioweather maps whether it's for influenza or heart disease. We can even leverage our social networks to understand who and when to shake hands with or not shake hands with that day based on other information. And I'm hopeful in whatever you're doing in the medical device [00:44:06] **or other** arena we can start to pull this information into actual forms, whether it's dashboards for your themes or your trial lists, and that we can shift healthcare from being scattered and empiric to one that's much more connected, contextual, and integrates design thinking so it's beautifully utilized and empowers us across the spectrum and can shift us from where we've been in healthcare traditionally, very much episodic and reactive. We wait for the disease to happen, so we react to the heart attack, the stroke, the complication, and the data has been very episodic and we're shifting to an era where we can be much more continuous with our data from these devices in other realms to much more proactive about picking up and preventing disease before it happens.

And so with that theme I think we can shift just from being blood and organ donors to being data donors and shifting our sensibilities across all the spectrums of healthcare, whether it's oncology, my realm, and beyond. So I hope I've given you a taste of exponential thinking, that you apply some of that in what you're doing next and today in your evolution of devices and beyond, and realize that a lot of these technologies are already here just like with Google Glass. And the

famous quote from Gibson, "The future's already here, it's just not evenly distributed." It's up to us, especially us in this room who are honored and privileged to help create some of these technologies, not to just predict the future medicine but to go out there and to create it. So with that I'll say thanks very much. Hopefully, you can join us at Exponential Medicine this fall, and you can track me down through Twitter or email. That's right there. So, thanks Joe.

Joe Hage: Thank you. Okay, so a show of hands, who understands now why I chose Daniel to be our keynote speaker? Was that awesome? Even more awesome is if you'll clap for him again. He is a new dad. Leo James Kraft was born on April 30 and…

Daniel Kraft: Quantified baby.

Joe Hage: So in addition to the pilot and to keep up with all the things he said he does, well, just throw it…who has ever changed the diap…oh, you get the idea. He's a really, really busy guy, so thank you so very much for fitting us in.

Daniel Kraft: Sure.

Joe Hage: I have questions but I'm going to hold them. I'm sure some of you do. As he spoke, I know enough people in the room to think, "Oh, that's a Rebecca. Oh, I know you want to…" Yeah. So, who would like to ask a question of Daniel? Eric. This is friendly fire.

Eric Knudsen: Very much so, but you did talk about the FDA and you mentioned that other people have impediments. Can you talk a little bit about standards and information interchange?

Daniel Kraft: I mean, I think many in this room maybe know more about this but with [00:46:49] **handling these other conferences** a lot of these devices, and I was just in the hospital delivering a baby, don't talk to each other, so they have different languages. We were at Stanford right when they switched over from [00:00:00] **Starter** to Epic and that was a bit of a disaster. I know it's called Epic fail. Sorry for those folks who are Epic fans. But a lot of these are, you know, technologies I'm wearing don't have the same data standards. They don't talk to each other and they're not always secure and compliant, and there are folks working on collaborating on developing so we're not in VHS and Betamax, which will hopefully speed their integration. Maybe Marty Kohn can talk to that a bit more next, leading up the convergence of technologies in the home to help make smart analytics, but I think that's super-critical. We can't all be speaking in different languages even though some of them can translate pretty quickly. I mean, there could be apps on this soon that can translate languages. So, we'll leave it at that.

Rebecca Herold: Hi, my name's Rebecca and I think that what you're describing is very exciting and so many benefits. My expertise is in information security and privacy and I literally took pages of notes as you're talking about all of this and the benefits. I'm thinking, "Okay, how is that data being controlled? How is it being protected? How are you controlling who it's shared with when I saw those social media sites pop up and all the data sharing with it?" Of course, I've dealt with a lot of those issues so I was wondering if you could briefly describe, what have you been doing with all of this great innovation to address the privacy and security issues?

Daniel Kraft: Well, I think it's, with folks like yourself, like I need to help guide that. I think we've seen that with the financial world. [00:48:36] **We wouldn't give them our** credit cards but those still get hacked. There are going to be some breaches of security at times. I think the challenge is I think most patients, they want to be able to donate their data in many cases, ideally in anonymous ways. I think HIPAA is a well-intentioned law but at this point some of its elements are somewhat impeding progress, at least from my perspective. I think we need to be smart about guiding the regulations and thinking exponentially a little bit because there's now a terabyte of data that can come off of our body every hour, who owns that and if it's crowdsourced by the patients. There are groups like patients like me [00:49:10] **and here** together and now sensibilities about [00:49:12] their own trials outside of the normal Moore's. There's the opportunity that we be careful about how we think about the data but also bringing it up a little bit. And I don't certainly have all the answers, but I hope we can blend the sensibilities of respecting privacy but also be able to collaborate and un-silo some of this, because even the data in all these EMRs don't talk to each other at all and there's this idea of not just doing restrospective, double-blinded, randomized trials to get data, but that's sort of evidence-based medicine. But to do practice-based medicine, take all the patients in my Epic or [00:49:42] **Starter** database or across the whole United States or world and say, "Who are the two patients who are also of this genotype and these three meds and this problem and how do they do?" and then make the choice between therapy A and B. So I think it's getting more and more complex and there's obviously ethical and other concerns, and we need to be smart about it but not to put the brakes on everything at the same time.

Vizma Carver: Hi, I'm Vizma Carver and am appreciative that you presented. I actually pioneered back in the nineties funding some of the first [00:50:10] **AIDS watches** before we even had the big brick, so you can imagine what the medication management back then. I **stripped** the [00:50:15] system and all that back in early 2000. One of the concerns I have is I used to wear a lot of those watches as well but it never tracked my biking, my Pilates, majority of my workouts. With all of

this data coming in, the quality of the data and really where you can take and make clinical decisions or even be able to present it to patients that that really does reflect how much weight you have or haven't lost or what your metabolism is.

Daniel Kraft: Yeah, you might be a part of a clinical trial and you can incentivize the walks, so you put your FitBit in your dog and it runs around. So the data, for some of it that doesn't matter so much. These might be 10% off, you know, they're different devices. If you're just trying to incentivize yourself to walk a little extra… But if it's part of a clinical trial and you're trying to get one of the value-based outcomes, it might be quality of life, ensuring that the patient with that new heart implant is actually getting around more than before, some of that may require better functionality and more objective measures. Some of this is just this whole Hawthorne effect that you know you're being measured changes behavior. And again, there are sort of still 1.0 devices and they're moving through the 3.0 version, and with GPS and they embedded parts of the phone they'll be more accurate. So it depends what you're doing. Some of the new ones will be able to tell whether you're biking or sleeping or running. It's not perfect yet and they're not yet really…they're still not really medical grade, but they will be and I think they can be important parts of clinical trials. I keynoted last year at the DIA conference, the big pharma conference where they look at clinical trials, and I was shocked at how backwards the clinical trial world still is. I think there's huge opportunity to disrupt that with these sorts of elements as well as to empower the patients and beyond.

Lisa Stemmer: Hi, thank you. It was an amazing speech. And I have an UP band, I have a Polar Loop, and I have a FitBit, so I totally understand the quantified self. But here's the thing: I go to my doctor and I'm like, "Oh my God, I think I have a…" And I show her my phone and she rolls her eyes. So can you talk a little bit about clinical adoption and about how clinicians feel about all of the patients coming in and doing this to the now physician?

Daniel Kraft: Sure. I think it's where the incentives are shifting. If your doc gets really incentivized and gets a bonus within the year for having the panel of patients including you with good blood pressure and exercise and beyond and not showing up in the ER unexpectedly, they'll be rewarded for that and they'll be incentivized to use this data off your phone or to prescribe you a blood pressure cuff or exercise device. One of the things we're doing with these bionic companies, enabling that feedback loop for the doc so it's integrated back into the electronic medical record. It's all about the workflow as well. You don't want to be logging into 10 different things. They don't want to log into your FitBit account. So I think as the incentives are aligned, and at Kaiser we'll hear from John Maddison

tomorrow, you know, they had a hard time getting the docs to even do email, right? But now they do and I think most folks are happy with it. Sometimes it's setting incentives or from down on high imposing those, and I think when, again, your physician is empowered and rewarded for using that data, they'll be more on top of it, but it depends on what system you're in because we have so many in the US and beyond.

Chris Newmarker: Hi, I write about medical devices. I'm a reporter. I'm trying to understand what you think the future medical device company should look like because you talked about we practice sick care and non-healthcare, and most medical device companies I would argue do that where the consumer is pretty much left out in dark [00:53:30] and… Well, the incentives are changing now and they have to turn their Titanics around, so what would be the characteristics with the program I guess, medical device company?

Daniel Kraft: I think it'll depend on the complexity of the device but with, again, your AICD or pacemaker you'll get an app that comes with that. You'll be understanding it every week. It will give you some highlights. It might even be tracking your activity and give you other extra bonus information. That report will come back automatically to Medtronic or whomever on a regular basis to help monitor your device. Some of them might be blended with this personalization part, so they might be 3D printed and match your anatomy. They'll have, again, apps that help track their compliance if they're not something that's implanted. They'll maybe be more personalized and tuned to the individual using analytics with the neuro pacemakers or GI pacemakers or other elements, and the way they're probably implanted will blend with smarter imaging and ways to truly pick the right patient and pick the right sizing. So I think it really depends on what kind of device you're talking about and what class, but I would just encourage everyone to sort of think about how all these different sensibilities will blend, and while there is not easy regulatory imbursement paths for all of those, hopefully that will lead to better outcomes. And even for the folks who are heading to sick or disease, you'll be at a different market. We're going to put some of these devices in early in smarter ways, so you'll have a broader market and hopefully simpler or smarter or safer devices.

Joe Hage: Daniel will be with us throughout the day. I'll take a question from Joe and then if there's one more, and then we'll move to our next speaker. Thank you.

Joe Doyle: Not really a question, just wanted to say great speech. Thanks again. I've seen you a couple times at South By and a lot of what you're showing here has definitely come to there. The basis was great. I was pleasantly surprised when they added cycling. I thought that was wonderful, and like you said it's kind of

version 1.0. And just to follow up on the lady's comment about custom exercises, the Atlas Wearable out of Austin is coming out and allowing people to actually create their own custom movements for monitoring, so it's one to watch. It should be out in December. I'm not affiliated. I'm just mentioning.

Daniel Kraft: In terms of customization, folks from had open source versions of these, so imagine if you're a device maker or doing a trial for Parkinson's and you can measure shake. That would be an example of something you could blend to this measuring emotion. So, lots of ways to think. And like with glass and other things and iPhone, could you imagine even 10% of the innovations that have been done on Android and iPhone in the last five, six years? We'll see some these things happen in the wearable space as well.

Juergen Klenk: Hi, Daniel, this is Juergen Klenk from Exponent. Great talk. I really enjoyed and learned a lot. One question you touched on actually a little bit I want to dig a little bit deeper into this, after all all these things are for us and we are the humans, so I think the inherent weakness here is the human link and getting humans to adopt behavior change and behavior accordingly to actually get some of the benefits that are out there. Could you comment a little bit on behavior, affecting behavior, research on behavior change, things like that?

Daniel Kraft: Great question. I think there's a lot of focus now on how do you get folks truly engaged and stay compliant with behavior change or beyond and my pet theory is just like personalized medicine: I want to give you the right drug at the right dose based on your genetics and your weight and your activity. We should do personalized behavior change. And you've all heard of Myers Briggs, like I'm an ENTP, you're an INTJ. What if we had a Myers Briggs for behavior change and I prescribe you an app and a device or an interface that was tuned…you like blue and social network points, and someone else likes red and entering a lottery or financial. So I think we can learn people's characteristics both including using feedback, neuro feedback. The camera on your laptops and devices can pick up your heart rate data. Your emotional state can tune things to you. So in a workplace, that can be utilized.

So, I think there's an opportunity not to give the same pamphlet to everybody and go say, "Exercise more and eat less," but to tune that based on behavior change, and that certainly applies to medical device compliance, drug compliance, and just general overall health. So I think psychology, social psychology, and some of these new sensors can pick that up very easily as well. I mean, the brain computer interface element will probably integrate into, you know, you're hearing about the new ear buds which do music but also pick up your heart rate, and I think the versions of glass which will sure shrink and look more sexy will also pick up your

brainwaves and also ways to integrate that for behavior change because that's the biggest drug therapy. Thanks.

Joe Hage: Dr. Daniel Kraft. Thank you very, very much. Great job.