CURALINK

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Welcome to CuraLink—a newsletter for innovators building a healthier future for all.

Dear Cura Community,

Welcome back to CuraLink, a newsletter and interview series featuring the most pressing issues in human health, unmet medical needs and the emerging innovations and technologies directed to address them.

Last month, we were fortunate to speak with Dr. Elissa Epel. The pioneering psychologist has devoted her scientific career to exploring the mind-body connection and shared with us some practical tools to tame toxic stress. Visit bit.ly/CuraLink-24 to learn how you could improve your stress resilience.

For the most part, CuraLink focuses on the most pressing health issues here on Earth. This month, we're going in a different direction—to outer space. Humans have always been fascinated by space and stars near and far. After the first spaceflight by Yuri Gagarin in 1961, the fascination started to look more like reality. Since then, people have been exploring the limits of our physiology in space and the effects of hypo- and hypergravity, radiation, isolation and confinement.

Robin L. Smith, MD
Founder, President and Chairman, Cura Foundation

Over the last six decades, space has become a driver of technological innovation on Earth. Research on the International Space Station has led to extensive advances in health and technology. The use of satellites has also helped drive innovation with ever-expanding applications on Earth from agriculture to energy and defense. To learn about the booming space economy and the ways that space impacts life and, specifically, health on Earth, we spoke to space economy strategist Kelli Kedis Ogborn.

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A conversation with Kelli Kedis Ogborn

Kelli Kedis Ogborn never expected to have a career in space. Like many kids, she was always fascinated with space exploration but didn't see a way to make it a reality. Today, Kedis Ogborn is one of the leading space economy strategists pushing the boundaries of what's possible in outer space. Soon, she'll head out on a Blue Origin suborbital flight and fulfill her childhood dream.

This isn't just a personal passion. Kedis Ogborn harnesses her unconventional background in sociology, science, technology and business to forge a new path in space. She now focuses on creating business strategies to develop and transfer vital technology to and from space. According to Kedis Ogborn, space is one area that can unite us all, no matter the background.

When it comes to space, it's not all rocket science. Breakthroughs in space technology have led to a range of new medical drugs and devices. As space technology gets better and cheaper, and the field attracts more interest and money, not only will spaceflight become more common, many industries will be transformed by zero-gravity advancements. Every industry, skill set and interest has a place in space, Kedis Ogborn said, "They just don't know it yet."

Kelli Kedis Ogborn, Vice President, Space Commerce & Entrepreneurship, Space Foundation

What inspired you to pursue a career in space?

If you asked me that 20 years ago, I would have laughed. I never thought there was a place for me in the space industry.

My academic background is in sociology, and I focused on conflict resolution and aid delivery in my early career. My path to space started while working on advancements in science and technology at the Defense Advanced Research Projects Agency (DARPA) in Washington, D.C. After DARPA, I ran a consulting firm for seven years specializing in tech commercialization. As a sociologist working in science and tech, I was always looking at the human side of breakthroughs—how tech developments play into other markets and impact people directly. That naturally translated into the space industry, especially with the rapid evolution of advancements and opportunities.

Looking at the future of space, many industries, backgrounds, interests and skill sets are already implicated in its growth. They just don't know it yet.

Was there a turning point when you realized that you could pursue a career in the space industry?

It was a progressive learning curve. When I started to help companies build strategies within the space industry, I realized that everything is interconnected with many unexpected cross-cutting disciplines involved.

"The space economy is anchored by familiar segments but driven by emerging markets. This allows for stability, creativity and risk to coexist at the same time."

The wonderful thing about the space industry is that we don't have an optics problem—people already think we're cool. Most people grow up fascinated by space but don't think there is a career path for them. Never in my wildest dreams would I have ever thought that I would be here.

How are technologies within the space industry benefiting the public on Earth?

I work for Space Foundation. Our organization quantifies the space economy annually, and it's currently estimated at $546 billion. That number is split into 78% commercial revenue and 22% global government spending. Ninety-five percent (95%) of the total is the "space-to-Earth" market. That means using space-based technology and data for things like GPS, precision navigation and zero-gravity manufacturing. This market hinges not only on how we utilize space and the conditions of space but also on how we transfer tech and knowledge from space to Earth.

Space is a tricky domain that attracts a lot of dreamers, inventors and frontiersmen. It also garners a lot of money. Luckily, when you're pushing the boundaries of what's possible in space, regardless of whether you achieve your goal, you induce trickle-down effects of better subcomponents, processes and protocols that will impact life on Earth.

How do breakthroughs in space influence health care on Earth?

Within the healthcare domain, the examples are immense. Many telemedicine tools, remote healthcare protocols and robotic procedures have been derived from space technology. High-resolution imaging devices, such as ultrasound and MRI, used on missions have been miniaturized and then improved upon for terrestrial health care. These developments are advancing and enhancing clinical diagnostics, medical capabilities and patient care.

"Engaging in and exploiting the conditions of space can enable better techniques here on Earth."

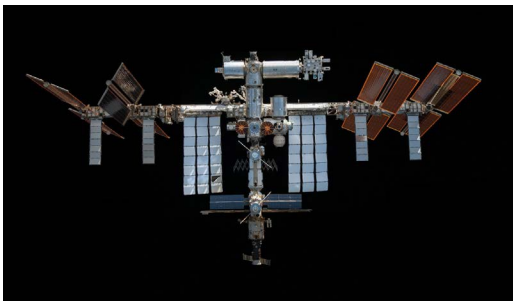
A lot of scientific research is currently conducted on board the International Space Station (ISS), but the ISS is scheduled to be decommissioned in 2030. Private companies have already been contracted to build various space stations that the National Aeronautics and Space Administration (NASA) and other stakeholders will use. When commercial space stations become established, even more research would be possible. Private citizens, research institutions and other companies would be able to put payloads on private space stations to conduct their research.

What are the health innovations (drugs, devices, etc.) in space medicine you could share with us?

Zero gravity (zero-G) provides an incredible experimental condition for manufacturing. Enabled by zero-G, scientists have manufactured medical devices with the size and sophistication necessary to implant in retinas. LambdaVision has been developing its protein-based artificial retina on the ISS. The device takes about a week to build and is intended to help patients with advanced retinal degenerative diseases, including retinitis pigmentosa and age-related macular degeneration.

Amgen accelerated the development of two osteoporosis treatments, romosozumab-aqqg and denosumab, by testing mice in microgravity conditions and generating evidence to support drug efficacy. The U.S. Food and Drug Administration later approved these medications. Using zero-G conditions, researchers have also improved upon treatments for the prevention of muscle and bone atrophy.

They are even growing organs on chips in space, which is only possible due to zero-G. The National Center for Advancing Translational Sciences at the National Institutes of Health and the ISS National Laboratory created the Tissue Chips in Space initiative to study the effects of microgravity on the human body and health and to use those findings to improve health on Earth. Researchers from the Wake Forest Institute for Regenerative Medicine are collaborating with Axiom Space and BioServe Space Technologies to develop a platform to manufacture 3D bioprinted liver tissue.



The International Space Station (ISS) is located in low Earth orbit around 240 miles (400 km) above sea level. Initially launched in 1998, the first crew arrived at the ISS in 2000 and it was completed in 2011. The ISS is a laboratory, observatory and research facility focused on studying the effects of space and using the conditions of space to further research (Photo by NASA Johnson)

In space medicine, inflammation and changes in astronauts' immune responses due to microgravity, high doses of radiation, hypergravity during 5G takeoff and landings and psychological stress play critical roles in long-duration flights. Understanding the inflammatory pathways involved could inform research for common conditions like dementia, traumatic brain injury, cancer, asthma and post-traumatic stress disorder. Breakthroughs in space will accelerate scientific research, tech development timelines and new business lines. That's only what's happening now. It's just going to speed up in the next five to seven years, which is really exciting.

Are there any current projects or research initiatives that you are excited about?

With the Artemis missions, part of the collective future that we are pushing for is going back to the Moon. One of the primary goals is to build a permanent infrastructure for research and to eventually utilize it for launch into farther orbits and planets. Artemis is a stepping stone for further exploration and deep space missions.

As a person immersed in space economy strategy, I have no doubt we will get there technologically. But to create this future, we need to create a scalable and sustainable growth model and solve some deeply human problems. When you put astronauts in conditions of isolation, lack of sunlight and high stress; they don't thrive for long durations, nor do we have the data to suggest how they will acclimate. How do you support people's physiological and psychological well-being so that their stress levels are managed and they can adapt to their surroundings?

Many rockets used today are automated. So astronauts are often engaged in tasks that don't require high-level cognitive engagement. They have idle time. And even though you've trained with your crew, they're still relative strangers. Advancements in augmented and virtual reality may one day help them feel more connected and transport them to more

"human-like" places—perhaps by seeing their family in a virtual living room or virtually walking through a field of flowers.

Dietary planning and nutrition are also critical. Right now, our only data is on astronauts on board the ISS. For long-duration missions, how do you plan for proper nutrition? How do you prepare the human body to optimize your physiological state and become resilient to future stressors?

Emergency management and response are important. How do you prepare, and what kind of pharmaceuticals or medical procedures could be needed?

Kelli Kedis Ogborn has always been fascinated with space exploration but didn't see a way to make it her reality. Today, she is one of the leading space economy strategists using her unconventional background in sociology, science, technology and business to forge a new path in space

Humans have been traveling to space since 1961. What have these missions taught us about human health? What does the research from the International Space Station show?

The lack of gravity is harsh on the human body. The body deteriorates over time in these conditions. Bones and muscles weaken. Astronauts could lose roughly 1% density in their weight-bearing bones for every month in space. Blood and bodily fluids migrate to the upper body due to a lack of gravity, and the face swells. Heart muscles can weaken because it is easier to deliver blood with less force.

To combat this, astronauts maintain a rigorous exercise and nutritional regimen that is monitored with biosensors and tracking devices. But we only have data on the ISS in low Earth orbit about 240 miles up. For context, you enter space 62 miles from sea level, and low Earth orbit extends to 1,200 miles.

When we talk about a prolonged and sustained human presence on the Moon and, eventually, Mars, we don't have data to inform that. People have only been to the Moon on very short missions.

So there's a lot of research to be done and technology to be developed. On top of existing medical procedures, pre-screening diagnostic testing, telemedicine and AI models will help us better support astronauts' potential needs. This is the next generation wave for human support in space and preparation for future space flights. I'm starting to see more of that in people's business models and budding collaborations among telehealth companies and companies like Dell using AI models, for example.

Closed-loop life systems are also mission-critical. Many of these are being developed in hospitals. When we go into isolated environments, we need to have a framework for self-sustaining healthcare ecosystems that will allow everything to coordinate.

Your body reacts differently to pharmaceuticals in different gravity environments and predicting these reactions in space is essential. Sleep science is also influencing rocket design. Astronauts sleep at a precise angle to account for predicted fluid shifts.

In a lot of ways, we're still working with hypotheses based on limited data.

Have you traveled to space and, if not, do you have any missions planned?

Not yet. And, yes, I will be going on a future mission with Blue Origin, which is thrilling. The suborbital flight will last between 17 to 20 minutes with about five minutes in zero gravity. And we'll be breaking the Kármán Line. For me, this flight surpasses a professional opportunity because I believe representation matters in space. Access to space is only continuing to increase—for suborbital flights (i.e., space tourism), research and development and business growth—as rockets become more reusable, reliable and cheaper to launch. I'm fortunate to be one of the early adopters of suborbital flights, but many more people will have access down the line. I want to show that it's worthwhile to take this risk for our collective future.

"Space, out of every domain, gives people hope."

The more that we can encourage people to engage in space in a meaningful way and understand how it not only captures the exploratory imagination but intrinsically affects us here on Earth, the more pride people will feel in this future and how we are working to move it forward.

What is your ultimate hope for impact in the space arena?

Perception. Humans have been going to space for a long time, but the field is still considered elite. Fewer than 700 people (and fewer than 100 women) have gone to space. Many people are space enthusiasts or space curious but don't see a career

path or how their work on Earth (and daily life, quite frankly) has direct implications in and to space. That is the biggest misconception I want to change.

My team and I at Space Foundation recently conducted a Mars habitat simulation in South Florida called Life on Mars with six interdisciplinary teams from different walks of life and ages ranging from 18 to 67. We put them through a very stressful simulation—with challenges, isolation, limited mobility and catastrophes—all while they were working to create a community design for how to sustain and scale life on the Red Planet. It was fascinating to watch from a collective humanity perspective. When you get really smart, creative, dedicated and passionate people at the table for a set purpose, you can accomplish a lot in a limited amount of time.

I want to advance the field, expand access to others and bring people to the table to help build a future in space. As a sociologist by training and having worked in science and tech for 17 years, I want to show that there is a place in space for everybody. With this in mind, I created a nonprofit called Place in Space that will be the legacy of my participation in this flight. The goal is to provide capital and resources for girls who want to go into space-related fields. No one should self-select out purely because they don't see a path or don't have access. I want to show people how their background, skills and interests fit in the future of space and provide opportunities for scholarships to pursue their dreams. I also want to spotlight and financially support female-led space businesses that are pushing the boundaries and creating mission-critical capabilities of the future.

What would you like to tell the many boys and girls fascinated about space?

The industry is evolving rapidly. Going to the Moon and Mars is no longer a myth; it's a real possibility. Space can give younger people a purpose to orient their education and dream bigger than what they think they can achieve. We are so fortunate to be in a time where we're not just reading about space exploration in science fiction novels. We're building the technology to go to these places, soon. So I'm excited for future generations. Their opportunities will be immensely different.

For the younger generations, I would say: "Keep being curious and constantly seek where you can be useful." This isn't your grandfather's space industry. It's not just rocket science. People from all backgrounds are betting on the future. A lot of universities and academic institutions are thinking about the space economy outside of aerospace engineering.

It's also humbling and exciting for the older generations. I've spoken with people who have been in the space industry from the beginning. They devoted their careers to ensuring that the human pioneering spirit still exists.

The 38th anniversary of the Challenger explosion occurred recently. It continues to show us that when you dare to do bold things, there are real-world risks and consequences. It is our job to ensure that the losses are not in vain and to learn from the lessons of the past to move forward. People are still willing to take risks because the collective future that we are pushing for is too big to not pursue. It's almost too big to fail. Setbacks are just stepping stones.

I love working in space because everybody is so excited about what they do. They really care. Beyond the grit and perseverance of people willing to strap themselves to a rocket and get propelled through the sky, it is inspiring to see how driven the people in the industry are who work tirelessly to make this possible. And it's just fun!

Kelli Kedis Ogborn during the Italian National Space Day at the Embassy of Italy in Washington, D.C. in 2022. Kedis Ogborn believes that space is becoming democratized, with many more countries and localities joining in. The benefits of space-to-Earth economy will continue to extend, as the number of satellites in orbit continues to grow over the next decade

Given the range of crises that people face on Earth, why should they care about space?

That is the number one question I get. I work a lot with countries and localities that either don't have a space strategy or are developing one. The number one thing that I always tell people is: "Make space make sense for you."

These are places dealing with critical challenges like droughts, fires and hunger. But as I mentioned before, 95% of the space economy is the space-to-Earth market. For example, space is impacting the agriculture sector. There are a lot of agriculture companies and farmers using space data and satellites to predict crop yields, droughts, fires and floods to help create a stable food supply.

Another interesting example is insurance. With higher-resolution space imagery on top of satellite data, insurers can now provide preventive and predictive insurance and secure things they weren't able to before. It's called parametric insurance.

In tech, for instance, cell phones have about 17 different pieces of space technology in them. GPS, precision navigation and even touch screens are all space tech. Online banking is space tech.

“Space matters in terms of collective optics. It is the one area that can unite us all.”

We all live on the same Earth, under the same sky and in the same galaxy. From space, looking down, we’re ultimately earthlings, not divided into countries. That can be humbling because we all share the same home.

How is space becoming democratized?

Space used to be a domain for the elite, not just astronauts but also for the countries involved, too. That is starting to change. Satellites are expanding access and revolutionizing the future. There are roughly 9,000 satellites in orbit. In the next 10 years, there will be over 100,000.

Rockets are becoming cheaper. That financial shift is going to democratize space and access to information. Private space companies, academic institutions and smaller, less-resourced nations can send satellites to space and conduct research to benefit their needs, from improving agricultural yields to testing hypotheses to address the challenges they face.

We can now put satellites over areas without internet connectivity. The implications for small remote villages could be incredible. But we have to think through the management, legal frameworks, accountability and regulation.

When we think about the collective future, it has to be integrative and collaborative. The Artemis Accords, for example, is a non-binding multilateral arrangement signed by 36 countries including the U.S. on how to peacefully engage in space. Although the space industry grew out of the space race, it’s becoming a lot more collaborative and inclusive. It’s about bringing the best and the brightest from different countries to integrate this infrastructure because no country will be able to do it alone.

Image of Earth from space taken on March 5, 2024, by the DSCOVR satellite’s Earth Polychromatic Imaging Camera (NASA)

How do we ensure that the transition from 9,000 to 100,000 satellites is sustainable, resource-wise?

Space has a lot of implications for the environment on Earth. Space is already congested with debris. The international community is concerned about making it sustainable, especially because we are hoping to engage in space more robustly.

It goes beyond the space stations now in low Earth orbit. We’re really looking at a cislunar or Moon-to-Earth economy and all of the infrastructure that will underpin it.

Environmentally, within low Earth orbit, there’s a concept called ISAM (in-orbit assembly, servicing and manufacturing), which, when built out, can take Earth out of the equation to do everything in space. The goal is to manufacture, refuel and repair satellites and rockets in space. Also, many new companies are looking toward solving issues like recycling space junk and manufacturing it for something else. One idea is to design satellites that are biodegradable or can be recycled on Earth.

“We need to protect space like we need to protect Earth because it touches every continent, country, city, community and citizen.”

What do you think it’s going to look like in the next 10, 20 or even 30 years? Are we going to Mars?

We will go to Mars, eventually. I have no doubts about that. But we have to ground the hype and optimism for the future with a practical roadmap. Similar to health care, we have to be realistic and iterative about what’s technologically possible now. We should have our collective sights set on the Moon and Mars but understand what it takes to get there.

In 10 years, I have no doubts that we will see an infrastructure powering low Earth orbit. By that time, the ISS should be decommissioned, and some of the private space stations and refueling depots should be set up. Within the next decade, the Artemis mission should be landing the next humans on the Moon, which is fantastic and exciting. There will be a surveillance mission to build out the infrastructure on the Moon. We will also have to figure out how to power things in space and return things to Earth.

I also wouldn’t be surprised if we have a mission to Mars in the next 30 years, which would be incredible. There’s never been a better time to become part of the space ecosystem or pay attention to its implications on Earth. We’re all building the future together and the more people we can have join our mission the better.

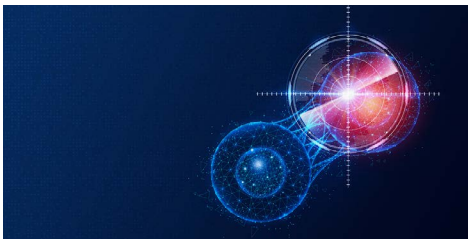
This interview has been edited for length and clarity.

Insights, Perspectives & Ideas

A Doctor's Lifelong Quest to Solve One of Pediatric Medicine's Greatest Mysteries

The New York Times, February 2024

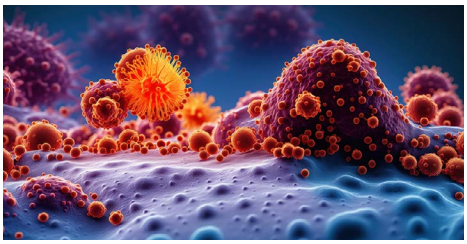
For 40 years, Dr. Jane Burns has been working to determine the cause of Kawasaki disease, a rare childhood illness that causes aneurysms and heart attacks in children and can impact heart and blood vessel health decades later. The disease usually occurs in children under 5 and is easy to miss because its symptoms are similar to scarlet fever, tick-borne illness and measles. Dr. Burns and her team have built the world's largest biobank of disease samples and a network of experts, including oceanographers, statisticians, cardiologists, historians, forensic pathologists, microbiologists and anthropologists, to help determine its cause and develop diagnostic tests. And today, they believe they have the tools to complete the mission.



Cancer Therapy Approved by FDA Uses Body's Own Cells as a 'Living Drug'

The Washington Post, February 2024

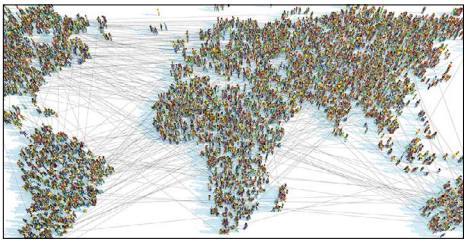
Scott Goedeke was the first person to undergo a first-of-its-kind cancer therapy that used his own cells to destroy his cancer. The therapy, called tumor-infiltrating lymphocytes, was approved by the U.S. Food and Drug Administration (FDA) to treat adults with skin cancer that cannot be surgically removed. The therapy, which involves injecting billions of cells back into the patient's body, aims to overpower the body's natural defenses and destroy the cancer. The FDA-approved therapy, Amtagvi™, is priced at $515,000 per patient and could mark the beginning of a new class of weapons against more common advanced solid tumors.



New Treatments Are Emerging for Type-1 Diabetes

The Economist, February 2024

The islets of Langerhans are clusters of beta cells in the pancreas. They produce insulin that regulates glucose levels and metabolism. If the immune system attacks the beta cells, it can wipe out up to 80% of them leading to type 1 diabetes. Although supplementary insulin can be administered, a better way might be to replace missing beta cells and protect them from immune attack. Researchers are exploring an approach to deflect the adaptive immune system, preventing the production of human leukocyte antigen proteins in lab-grown beta cells destined for transplant. Another approach involves introducing a suppressor cell to calm killer T-cells that attack beta cells and boost insulin production.



More Than 1 Billion People Have Obesity, Including 159 Million Young People, Study Estimates

STAT, February 2024

A new study published in *The Lancet* estimates that over 1 billion people worldwide are obese. Obesity quadrupled in children and teens and doubled among adults between 1990 and 2022. It is growing in low- and middle-income countries, with the biggest increases in youth obesity rates in Polynesia, Micronesia, the Caribbean, Latin America, the Middle East and North Africa. Many countries now face a "double epidemic" of malnutrition and obesity. The World Health Organization's director of nutrition and food safety, Dr. Francesco Branca, urged officials to adopt policies that address both issues, such as improving nutrition early in life through breastfeeding, regulating food marketing, facilitating physical activity and providing nutrition services in primary care.

Maternal Mental Health Conditions Drive Climbing Death Rate in US, Research Says

CNN Health, February 2024

A new evidence review found that maternal mental illness is the leading cause of pregnancy-related deaths in the U.S., with suicide and opioid overdose responsible for nearly 25% of deaths. The U.S. maternal mortality rate is three times greater than in other high-income countries. The review reveals that women are at higher risk for psychiatric disorders during and immediately after pregnancy, but only 20% are screened for postpartum depression. Access to comprehensive maternity care is limited in many states, increasing stress and the risk of untreated health complications. More national initiatives like the White House Blueprint for Addressing the Maternal Health Crisis are needed to prioritize maternal mental health.

This Is What Your Brain Does When You're Not Doing Anything

Wired, March 2024

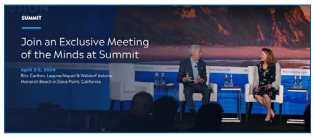
Researchers found that the brain has a default mode network, a collection of seemingly unrelated brain regions, that is active even when we're not doing much. This discovery offers insights into how the brain functions outside of well-defined tasks and prompted research into the role of brain networks in managing our internal experience. The default mode network, which includes memory, experience replay, prediction, action consideration, reward/punishment and information integration, may help construct an internal narrative and interacts with the salience network that helps identify relevant information. Mental health disorders like depression may be linked to problems with the default mode network. Thus, understanding connectivity differences is a starting point for further research.

Updates & Events

- The SXSW conference was held from March 8 to 16 in Austin, Texas. SXSW's Health and Medtech Track addressed how technological and social changes are impacting one of the world's largest industries and covered everything from patient-centric care and gene editing to health equity and 3D-printed human organs. Learn more at sxsw.com/conference/health-and-medtech/

- STAT 2024 Breakthrough Summit East was held in New York, New York, and virtually on March 21. "Focusing on patients—for real" was the title of this summit, but what does that mean? How should patient voices shape regulation, commerce and the practice of medicine? Industry experts, CEOs and patients discussed how biotech and health technology are crucial for improving patient experience, shaping R&D efforts and ensuring science benefits those in need. Learn more at statnews.com/2024/summit/2024-breakthrough-summit-east

- The 2024 Health Evolution Summit will take place on April 3-5 in Dana Point, California. The summit will convene a group of policymakers committed to healthcare transformation and CEOs from health system, health plan and life science organizations. The three-day event covers a wide range of issues that are shaping the future of health care including care delivery design, payment redesign, community-focused health, innovation and discovery, mental and behavioral health and organizational transformation. Learn more and apply to attend at healthevolution.com/summit/



- The 2024 Cell & Gene Meeting on the Mediterranean will be delivered in a hybrid format with live programming available from April 9 to 11 in Rome, Italy. The conference brings together the advanced therapy medicinal products community from Europe and beyond to cover a wide range of commercialization topics from market access and regulatory issues to manufacturing and financing the sector. Learn more and register at meetingonthemed.com

- NEJM AI is hosting Regulating Medical AI—Staying Safe in the Fast Lane, a free virtual event to discuss the regulation of AI on April 10 from 12:00 to 2:00 pm ET. Some of the topics include international approaches and alignment in AI regulation, regulating AI as a medical device and post-market surveillance and monitoring of ongoing AI performance. Learn more and register at events.nejm.org/events/684

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