UNITED STATES OF AMERICA

DEPARTMENT OF HEALTH AND HUMAN Services

FOOD AND DRUG ADMINISTRATION

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CENTER FOR DEVICES AND RADIOLOGICAL HEALTH

MEDICAL DEVICES ADVISORY COMMITTEE

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PATIENT ENGAGEMENT ADVISORY COMMITTEE

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JULY 12, 2022

10:00 a.m. EST

Via Zoom Videoconference

PANEL MEMBERS:

Paul T. Conway	Chair
Amye L. Leong, M.B.A.	Voting Member
Bennett R. Dunlap, M.S.	Voting Member
Monica L. Willis Parker, M.D.	Voting Member
Rita Roy, M.D.	Voting Member
Phillip X. Rutherford	Voting Member
Mary (Suzanne) Schrandt, J.D.	Voting Member
Teresa Diaz	Consumer Representative
Heather R. Adams, Ph.D.	Temporary Non-Voting Member
Colleen M. Gallagher, Ph.D., LSW, FACHE	Temporary Non-Voting Member
Grace Levy-Clarke, M.D.	Temporary Non-Voting Member
Omer Liran, M.D.	Temporary Non-Voting Member
Naiem Nassiri, M.D.	Temporary Non-Voting Member
Stephen B. Wilcox, Ph.D., FIDSA	Temporary Non-Voting Member
Diane M. Johnson, M.S.	Industry Representative

Letise Williams Designated Federal Official

FDA Representatives:

Kathryn Capanna
Deputy Director, Division of All-Hazards Response, Science & Strategic Partnerships, Office of Strategic Partnerships Technology Innovation (OST)

Brendan O'Leary
Acting Director, Digital Health Center of Excellence, OST

Anindita Saha
Assistant Director, Digital Health Center of Excellence, OST

Angela Krueger
Deputy Director for Regulatory Policy, Office of Product Evaluation and Quality

FDA Presenters:

Leeda Rashid, MD, MPH, ABFM,
Physician, Digital Health Center of Excellence, Office of Strategic Partnerships and Technology Innovation, CDRH, FDA

Industry Presenters:

Jennifer N Avari Silva, MD
CCEP-PC, FHRS, FAHA, FACC, Co-Founder & CoInventor Sentiar, Co-Founder & Co-Inventor Excera

Josh Sackman
Co-Founder and President, AppliedVR

Healthcare Presenters:

Walter Greenleaf, PhD
Neuroscientist, Virtual Reality, and Digital Health Expert, Stanford University

Jeffrey I. Gold, PhD
Professor of Anesthesiology, Pediatrics, and Psychiatry & Behavioral Sciences, Keck School of Medicine, University of Southern California

Juan Espinoza, MD
FAAP, Assistant Professor of Clinical Pediatrics, Children's Hospital Los Angeles, Keck School of Medicine, University of Southern California

Courtney Lyles, PhD
Associate Professor, Center for Vulnerable Populations, University of California, San Francisco

Sharif Razzaque, Vision Therapy Patient

VIRTUAL BREAKOUT SESSION MODERATORS:

Fraser Bocell
Chris Harner
Bart Sachs
Jessica Weinberg
Caiyan Zhang
Anil Kochhar
Allen Chen

OPEN PUBLIC HEARING SPEAKERS:

Theodora Scarato, M.S.W.
Executive Director, Environmental Health Trust

Kavya Pearlman
Founder & CEO of XRSI, Founding member of Medical XR Advisory Council

Emmy Schwab
Patient

Shweta Daga
Director of Regulatory Affairs Align Technology Inc.

Roger Holzberg
Co-Founder, Reimagine Well
Debbie Wagers, MHA, CCLS
Boys Town Research Hospital

John Tawfik, DPT, GCS
Director of Clinical Services with Accelerated Care Plus

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MEETING

(10:00 a.m.)

MR. CONWAY: Good morning. I would like to call this meeting of FDA's Patient Engagement Advisory Committee of July 12th, 2022, to order. This is Paul Conway and I have the honor to serve the FDA and my fellow patients as the chair of this committee. I'm a kidney patient of 42 years and I've been a transplant recipient for the past 25. I serve as the chair of the American Association of Kidney Patients, Policy, and Global Affairs Committee.

For those who are watching the proceedings of this committee for the first time and for those who are joining us again, I believe it is important to take a moment to highlight the distinctive nature of this FDA advisory committee. The Patient Engagement Advisory Committee is the only FDA advisory committee that is comprised solely of patients, caregivers, and patient advocates.

The stated purpose and general function of the committee is to provide advice and recommendations to the Agency on complex issues related to medical devices, the regulation of devices and their use by patients. Our first meeting occurred in the fall of 2017. The advisory committee's structure and process is the most formal and public way the U.S. Food and Drug Administration can receive advice from the American public on scientific issues. From this standpoint alone, the formal creation of the PEAC by FDA was a significant and substantive recognition of the importance of patient, consumer and caregiver insights on matters that are within the regulatory purview of the FDA.

The PEAC is comprised of members with unique lived experiences as patients, caregivers, and patient advocates. Throughout the course of our advisory committee operations, our deliberations have been informed by and have benefited from a wide variety of

other expert participants. For example, joining us today we have additional experts participating with insights on bioethics, neurodevelopment, human factors, augmented reality, virtual reality, mixed reality, ophthalmology, and pediatrics.

The PEAC operates when polling tells us that many Americans express concerns about the capacity and responsiveness of government to address the immediate and long-term problems faced by citizens and patient consumers. Some have doubts whether or not small groups of citizens working collaboratively together can impact the policy process. So, it's a fair question to ask whether this advisory committee has made an impact on shaping and informing solutions that benefit everyday Americans who depend upon or may depend upon medical devices to maintain their health or improve their health outcomes.

The answer to that question by the PEAC is that yes, we have made an impact and we continue to do so, and we have an honor as participants and members of the PEAC to participate in the policy process.

Our first meeting ultimately led the FDA to issuing final guidance through a document on patient engagement in the design and conduct of medical device clinical studies, guidance that has been embraced across multiple industries as well as among medical and research professionals.

Additionally, the PEAC has provided substantive feedback to the FDA on communications of stakeholder engagement related to product safety concerns and product recalls. Further, the PEAC has provided unique insights to the FDA on a wide spectrum of timely and emerging issues on both national and medical -- of both national and global significance on the medical innovation landscape. These include feedback on patient-generated health data and potential social media insights, artificial intelligence and machine learning for medical devices and

current and future concerns related to cybersecurity and medical devices.

Beyond the PEAC, FDA has welcomed and expanded the involvement of patients through participation in multiple venues in its stakeholder meetings including the more than year-long process associated with the negotiations related to the medical device utilization amendment. The elevation of patient consumers, and the unique insights across the medical device development lifecycle and within FDA processes is a far broader and more profound evolution in how patients and their experiences are valued by experts in the medical professions, government, industry, and academia.

This evolution is associated with the creation and higher acceptance of the science of the patient insights, and my fellow PEAC members and I are very pleased to continue to make contributions to the FDA and this emerging science.

I note for the record that the nonvoting members constitute a quorum as required by 21 C.F.R. Part 14. I would also like to add that the committee members participating in today's meeting have received training in FDA device law and regulations.

For today's agenda the committee will discuss and provide advice on augmented reality and virtual reality medical devices. AR/VR devices are increasingly applied to healthcare settings across the patient's care continuum from diagnostics to clinical decision making to surgical support into directly treating patients.

AR/VR devices are used across multiple medical specialties. These devices have novel attributes and considerations for patient and providers that impact FDA's evaluation of the device's safety and effectiveness.

The novel attributes of digital health visualization, tracking techniques, embedded software, among other factors, present unique challenges for pre and post market evaluation.

The advice provided by the committee will address factors the FDA and industry should consider when evaluating the benefits, risks, and uncertainty for AR/VR medical devices. The committee will also consider challenges to specific populations, for example, pediatric patients or patients who are cognitively impaired who may use this technology. Additionally, the committee will discuss ways patient perspectives could be incorporated into FDA and industry's decision making as well as the healthcare provider decision-making process related to using or prescribing the technology.

Now I would like to set out a few ground rules. If a panelist would like to ask a question, please physically raise your hand and I will get to your questions as we proceed throughout the day.

We want to prevent multiple persons from speaking over each other since this entire meeting is being transcribed for the official record, and it's not easy being a transcriptionist so please follow the rules.

Before we begin, I would like to ask our distinguished Committee Members and FDA experts, identified on the meeting roster and attending virtually to introduce themselves. Committee members please turn on your video monitors if you have not already done so and unmute your phone before you speak.

I will call your name. Then please state your area of expertise, your patient and/or caregiver role as it pertains to PEAC, your position, and professional affiliation. I would like to go ahead and start with Mr. Bennet Dunlap.

MR. DUNLAP: Paul, thank you. Good morning. My name is Bennet Dunlap. I'm the father of four now young adults -- maybe not so young anymore. It's kind of scary. Anyway, two of them have lived with Type I diabetes for a decade and a half. Like millions of other

Americans, I have type two diabetes and I've lived -- worked well with it. After decades as a banker, I earned a Masters in Science and Health Communications to better advocate for people with diabetes, and I'm thrilled to be here to be able to contribute today. Thanks, Paul.

MR. CONWAY: Thank you very much, Bennet. Ms. Amye Leong.

MS. LEONG Good morning, everyone. I'm assuming you all can hear me. It's a delight to be with you especially from California which is three hours behind you, and so getting up at early morning hours is a wonderful thing. I myself am a patient advocate, patient first, diagnosed with rheumatoid arthritis at the age of 18 and since then the holder of not only going through lots of medications that did not work, but the holder of 21 joint replacements, the last of which I had an infection in, so I went through the whole infection route and almost lost my leg, so I'm really delighted to be here.

I have served in a variety of capacities representing the Arthritis Foundation, Charity Arthritis Foundation, and have worked at the international level as the international spokesperson for the United Nations initiative called the Bone and Joint Decade, which still continues today.

I'm delighted to be a part of PEAC. Patient engagement has been my mantra ever since I was diagnosed and it has become slowly an industry, and I'm delighted to be a part of it with you all, in that regard. We have a long way to go but I applaud the FDA for its work in this area to engage us all. Great to be here.

MR. CONWAY: Thank you very much, Amye. Dr. Monica Willis Parker.

DR. WILLIS PARKER: Good morning, everybody. My name's Monica Parker. I'm a family physician in geriatric primary care provider professionally. I now serve as director of education and outreach for the Goizueta Alzheimer's Disease Research Center at Emery University. In my

personal life I am the primary caregiver for a 96-year-old with Alzheimer's dementia.

MR. CONWAY: Thank you, Dr. Parker. Dr. Rita Roy.

DR. ROY: Good morning, everybody. It is a real honor to be a member of the Patient Engagement Advisory Committee. I am a surgeon by training. I spent a career in medical education and found myself as a patient needing a spinal fusion and looking for information in patient advocacy and realized that there was a lot of work to be done there so I am now the CEO of the National Spine Health Foundation where we support patients on their journey to good spinal healthcare.

I am also the recipient of a total knee replacement, so I've been a patient in this area numerous times, and finally I'm happy to serve on the U.S. Spine and Joint Initiatives Executive Committee, so we're working together in musculoskeletal disease to -- my job to primarily raise awareness and advocate for patients in spine.

MR. CONWAY: Thank you very much. Mr. Philip Rutherford.

MR. RUTHERFORD Thanks. My name is Phil Rutherford. I am a person living in long term recovery from substance abuse disorder. In my professional life I am the chief operating officer of an organization called Faces & Voices of Recovery, and we're an advocacy organization for people with substance abuse disorders and in recovery from that. Glad to be here.

MR. CONWAY: Thank you very much, Philip. Mary Schrandt.

MS. SCHRANDT: Hi, good morning. I'm Suz Schrandt. I'm a fellow patient, grew up with polyarticular juvenile idiopathic arthritis, diagnosed right around my 14th birthday. I'm a lawyer by training and worked in health and disability law and policy, but I've actually been doing patient engagement since before we called it patient engagement. The very first activity I took part in as an 18-year-old, I was embedded in my local medical school curriculum as a patient

instructor using our bodies and our joint damage as teaching tools.

Like Amye, I've got multiple joint replacements and will likely need many more. I'm grateful for that technology. It keeps me going, but I'm hopeful they continue to get even better over time. I've had the great privilege and fortune of doing national and international work in the patient engagement space with time spent at PCORI as the Deputy Director of Patient Engagement, and now I play a number of roles leading various patient engagement efforts. And so, it's just a true privilege and honor to be with all of you and I really enjoy our time together, so I look forward to our meeting today.

MR. CONWAY: Thank you very much, Suzanne. Ms. Teresa Diaz.

MS. DIAZ: Hi. My name is Teri Diaz, and I am cofounder of GPAC, which is a Global Patient Advocacy Coalition, and I also co-facilitate the breast implant health summit. I am a patient that was bedridden due to a medical device. And once I had that medical device removed from my body, I regained my health and so -- and I was not given the proper informed consent of that medical device, so I advocate for patients to make sure that they are -- have proper informed consent. And I'm happy to be the voice the voiceless, so thank you for having me.

MR. CONWAY: Thank you very much, Teri. Dr. Heather Adams?

DR. ADAMS: Hi. Good morning and thank you for letting me participate. I am Heather Adams. I'm a pediatric neuropsychologist at the University of Rochester Medical Center where I serve as Associate Professor in the Department of Neurology. My research is focused on pediatric rare diseases and other pediatric conditions where we're interested in understanding neurodevelopmental or other behavioral consequences of neurologic medicines. I also serve as a member of the American Disease Advisory panel in PCORI presently. Thank you for having

me.

MR. CONWAY: Thank you very much, doctor. Dr. Colleen Gallagher.

DR. GALLAGHER: Good morning, everyone. Again, Colleen Gallagher, and I am a bioethicist, and my primary role at the moment is to be the Executive Director for Clinical Ethics and Chief of Integrated Ethics at MD Anderson Cancer Center which is part of the University of Texas system. And I also work globally as a research scholar for the UNESCO chair for Bioethics and Human Rights as well as other organizations. And it is my absolute privilege to spend the time learning from all of you today and sharing my little bits of wisdom. Thank you.

MR. CONWAY: Thank you very much, Dr. Gallagher. Dr. Grace Levy-Clarke.

DR. LEVY-CLARKE Good morning. I'm Dr. Grace Levy-Clarke. I'm an ophthalmologist by training with a specialization in autoimmune eye diseases. I'm currently an Associate Director of the Autoimmunology Service at West Virginia Eye Institute. In the advocacy space I've been involved with the Arthritis Foundation as a former medical honoree in the Tampa Bay area, I also work with juvenile arthritis and sarcoidosis. My area of interests in advocacy is early diagnosis and treatment and helping to mitigate -- mitigation strategies for health disparity for patients who have autoimmune rare diseases. Thank you for having me.

MR. CONWAY: Great. Thank you very much. Dr. Omer Liran.

DR. LIRAN Yeah. Hi, everyone. It's really a pleasure to be here. I'm Dr. Omer Liran. I'm a psychiatrist, currently an Assistant Professor of Psychiatry at Cedars-Sinai and Codirector of Virtual Medicine where we use virtual and augmented reality for research purposes and also try to clinically help patients. My work as a specialty specially involved with chronic pain and anxiety. My wife has juvenile arthritis, so I see the effects of chronic pain firsthand and working tirelessly to try to find alternative treatments to try to help her and many people like her living

with chronic pain.

MR. CONWAY: Thank you very much. Dr. Naiem Nassiri.

DR. NASSIRI: Hey, good morning, all. I'm Naiem Nassiri here. I'm a vascular surgeon. I'm an Associate Professor of Vascular Surgery at Yale University. I serve as an integral member of the Aortoiliac Institute. My practice primarily focuses on complex minimally invasive treatment of thoracal anomaly or acropathies. I also -- I am a co-director of our Congenital Vascular Malformations program with an international referral basis. And it's a pleasure to be here, and I'm humbled in your presence and look forward to contributing the best way I can.

MR. CONWAY: Thank you, Dr. Nassiri. Dr. Steven Wilcox.

DR. WILCOX: Good morning. I'm happy to be here as well. I'm the founder and the Chairman of the Board of Designed Science, a consultancy with offices in Philadelphia, Chicago and Munich. I've spent the last 40 or so years working with medical device manufacturers to reduce error as much as possible. I'm a human factors professional. And despite my advanced age, I don't seem to be suffering from anything, at least for the moment, knock on wood.

MR. CONWAY: Thank you very much. Ms. Diane Johnson.

MS. JOHNSON: Good morning and thanks for having me. I am the industry representative, I work with -- I work for Johnson & Johnson med tech, and my expertise is -- I focus primarily on FDA policy as well as digital health globally and trying to drive harmonization to ensure patient access for these critically important products.

MR. CONWAY: Great. Thank you very much, Diane. And now for FDA officials, Kathryn Capanna.

MS. CAPANNA: Hi. Good morning. I'm Katie Capanna and I'm a Deputy Division Director here at FDA's Center for Devices and Radiologic Health in our office's Strategy Partnerships and

Technology Innovation. We operate the Patient Engagement Advisory Committee working in collaboration each year with all of the members that you've just met, as well as different programs across our center on a variety of topics of importance to patients and caregivers and with direct impact on those regulatory missions of the FDA to protect and promote public health.

On behalf of all of my FDA colleagues, we thank each member of this committee for taking time out of their busy lives to prepare for this meeting and to spend the next two days with us. And thank you also for those of you following along virtually. We look forward to the discussion and for hearing your insights and advice.

MR. CONWAY: Thank you, Katie. Mr. Brendan O'Leary.

MR. O'LEARY: Good morning, my name is Brendan O'Leary and I'm the Acting Director of the Digital Health Center of Excellence at FDA's Center for Digital Devices and Radiological Health. I'll just reiterate what Katie said. I look forward to the session today.

MR. CONWAY: Thank you very much, Brendan. Ms. Angela Krueger.

MS. KRUEGER: Good morning. I'm Angie Krueger --

>> Sorry, you muted. Can you unmute?

MS. KRUEGER: There we go. I'm Angie Krueger, I'm the deputy director for regulatory policy in the office of product evaluation and quality in CDRH. This office is in charge of handling the total product lifecycle review of medical devices including pre-market, post-market and compliance activities, and I'm really honored to be able to participate in the conversation today.

MR. CONWAY: Great. Thank you very much. And finally, but not least, Ms. Anindita Saha.

MS. SAHA: Thanks, and good morning to everyone. Just to reiterate my FDA colleagues, we appreciate everyone being here and look forward to the discussion and I'm Anindita Saha, Assistant Director in our Digital Health Center of Excellence, and look forward to hearing your perspectives on AR/VR devices.

MR. CONWAY: Great. Thank you very much. Now Letise Williams, the designated federal office for the Patient Engagement Advisory Committee, will make some introductory remarks.

MS. WILLIAMS: Good morning. I will now read the FDA's conflict of interest disclosure statement for the particular matter of General Applicability for the Patient Engagement Advisory Committee, July 12, 2022, meeting.

The Food and Drug Administration (FDA) is convening today's meeting of the Patient Engagement Advisory Committee under the authority of the Federal Advisory Committee Act (FACA) of 1972. With the exception of the industry representative, all members and consultants of the Committee are special Government employees or regular Federal employees from other Agencies and are subject to federal conflict of interest laws and regulations.

The following information on the status of this Committee's compliance with federal ethics and conflict-of-interest laws covered by, but not limited to, those found at 18 U.S.C. §208, are being provided to participants in today's meeting and to the public.

FDA has determined that members and consultants of this Committee are in compliance with Federal ethics and conflict-of-interest laws. Under 18 U.S.C. §208, Congress has authorized FDA to grant waivers to special Government employees and regular Federal employees who have financial conflicts when it is determined that the agency's need for a particular individual's services outweighs his or her potential financial conflict of interest.

Related to the discussions of today's meeting, members and consultants of this Committee who are special Government employees or regular Federal employees have been screened for potential financial conflicts of interest of their own as well as those imputed to them, including those of their spouses or minor children and, for purposes of 18 U.S.C. §208, their employers.

These interests may include investments; consulting; expert witness testimony; contracts/grants/CRADAs; teaching/speaking/writing; patents and royalties; and primary employment.

For today's agenda, the Committee will discuss and make recommendations on the topic of “Augmented Reality (AR) and Virtual Reality (VR) Medical Devices."

AR/VR devices are increasingly applied to healthcare settings across the patients' care continuum from diagnostics to clinical decision making, to surgical support, and to directly treating patients, AR/VR devices are used across multiple medical specialties.

These devices have novel attributes and considerations for the end users that impact FDA's evaluation of the device's safety and effectiveness.

Based on the agenda for today's meeting and all financial interests reported by the Committee members and consultants, a conflict-of-interest waiver has been issued in accordance with 18 U.S.C. §208(b)(3) to Dr. Omer Liran. Dr. Liran's waiver addresses his employer's future licensing potential of the VR Software application. Dr. Liran is identified as a co-inventor and developer of a VR Software. Dr. Liran and his employer are entitled to revenue if the software application is licensed, but they do not currently generate any revenue.

The waiver allows this individual to participate fully in the Committee deliberations. FDA's reasons for issuing the waiver are described in the waiver documents, which are posted

on FDA's website at http://www.fda.gov/AdvisoryCommittees/default.htm.

Copies of the waiver may also be obtained by submitting a written request to the Agency's Division of Freedom of Information, 5630 Fishers Lane, Room-1035, Rockville, MD 20857.

Ms. Diane M. Johnson is serving as the industry representative for Digital Health Technology/Artificial Intelligence and is acting on behalf of all related industry. She is employed by Johnson & Johnson.

For the record, the Agency notes that Dr. Jeffrey Gold, who is an invited guest speaker with us today, has acknowledged interests with affected firms in the form of stocks, and technical services/employment. Dr. Walter Greenleaf who is also an invited guest speaker with us today, has acknowledged interests with affected firms in the form of investments/stocks and consulting/advisor. Dr. Courtney Lyles, another invited guest speaker with us today, has acknowledged interests with affected firms in the form of a research contract and technical services/employment. Dr. Juan Espinoza who is also an invited guest speaker with us today, has reported no interests or professional relationship with any of the affected products or firms. Mr. Sharif Razzaque another invited guest speaker with us today, has reported no interests in relation to today's meeting.

We would like to remind members and consultants that if the discussions involve any other products or firms not already on the agenda for which an FDA participant has a personal or imputed financial interest, the participants need to exclude themselves from such involvement and their exclusion will be noted for the record.

FDA encourages all other participants to advise the Committee of any financial relationships they may have with any firms at issue.

A copy of this statement will be available for review and will be included as part of the official transcript.

Thank you.

For the duration of the Patient Engagement Advisory Committee Meeting on July 12, 2022, Dr. Heather R. Adams has been appointed to serve as a Temporary Non-Voting Member.

For the record, Dr. Adams serves as a consultant to the Gastrointestinal Drugs Advisory Committee in the Center for Drug Evaluation and Research. This individual is a special Government employee who has undergone the customary conflict of interest review and have reviewed the material to be considered at this meeting.

The appointment was authorized by Russell Fortney, Director, Advisory Committee Oversight and Management Staff, on June 15, 2022. Before I turn the meeting back over to Mr. Conway, I'd like to make a few additional general announcements.

In order to help the transcriber, identify who is speaking, please be sure to identify yourself each and every time that you speak.

Transcripts of today's meeting will be available from Translation Excellence, Inc., 1050 Connecticut Ave., N.W., Washington, DC 20036. Tel: 720-325-0459

The press contact for today's meeting is Lauren-Jei McCarthy. For the record, FDA has received 2 written comments. Individuals that are confirmed participants for the Virtual Breakout Session have already received Zoom access for this portion of the meeting. Virtual Breakout participants will be instructed by the Chair to log out of webcast and log into the zoom platform to be placed in virtual breakout rooms during the 12:20 P.M. break.

Due to limited technology capacity, participation in the virtual breakout scenario discussion will be limited to 150 participants. Once capacity reaches 150 participants, the

virtual breakout session will be closed to additional participants.

Please note that the Virtual Breakout Session will not be webcast. The Webcast will close at approximately 12:20 P.M. The Webcast will remain closed during the Lunch Break. The Webcast will reopen at 1:25 PM to allow the general public, as well as those, that participated in the Virtual Breakout Session, time to rejoin the webcast before we begin the Virtual Breakout Summations at 1:30 P.M.

Thank you very much. I will now turn the meeting over to the Chair, Mr. Conway.

>> Sorry. Mr. Conway, you're muted. If you can start from the beginning.

MR. CONWAY: My apologies. Thank you very much, Ms. Williams. Before I ask the FDA to begin with opening remarks, I want to provide a brief overview of how today's meeting will run, once again to make certain that everyone understands the details.

During the morning we will have presentations from FDA, as well as perspectives from a healthcare researcher and an industry speaker, followed by a 10-minute break. When we return from break, we will continue with presentations from an industry speaker, a healthcare provider, a healthcare researcher, and a patient. This will be followed by Open Committee Discussions. Once the Open Committee Discussions conclude we will break for approximately 10 minutes.

During the break, I ask that those confirmed as participants for the Virtual Breakout Session log into the Zoom link they were provided so the virtual breakout session can start promptly at 12:30 P.M. Once the virtual breakout session participants are logged in to Zoom, they will be automatically placed in their assigned virtual breakout rooms. Virtual breakout session participants will be asked to participate in the scenario discussion questions that were provided to them and posted on the FDA website along with other materials for this meeting.

It is very important to note that this portion of the meeting will not be publicly webcast. The Committee members and the webcast will not be available during the virtual breakout discussions.

FDA staff will serve as moderators and notetakers during these discussions and will provide the virtual breakout participants with the ground rules for the discussion. FDA staff will not be providing their thoughts or comments during the Virtual Breakout session. Instead, they will summarize the discussion and report back to the Committee the comments made by the Virtual Breakout participants.

The virtual breakout discussions will conclude at 1:00 P.M. At 1:00 PM the public will have a lunch break for 30 minutes. The webcast will re-open for public viewing at 1:25 PM. Just to be clear, I want to reiterate that I will ask the A/V team to close the webcast for public viewing during the 12:20 break and the webcast will remain closed through the 1:00 PM Lunch Break. The webcast will reopen for public viewing at 1:25 PM.

Please note that those who participated in the virtual breakout session will no longer have access to the zoom platform and will also need to rejoin the webcast to continue viewing the meeting.

When the Committee returns from lunch, we will proceed with the virtual breakout summations. FDA moderators will then summarize the virtual breakout discussions for the Committee. Once the Virtual Breakout Summations conclude we will proceed with the Open Public Hearing. After the Open Public Hearing concludes, we will proceed with Open Committee Discussions. During this time, the Committee will have an opportunity to discuss the comments from the Virtual Breakout Session as well as the comments shared during the Open Public Hearing. Once the Open Committee Discussion concludes, I will give closing remarks and

we will adjourn for the day.

It is now a little bit after 10:30 a.m. and we will precede with opening remarks from Dr. Jeff Shuren, Director of the Center for Devices & Radiological Health at the FDA. Dr. Shuren, you may now begin your remarks.

DR. SHUREN: Thank you very much. Good morning, everyone, and welcome to our 2022 meeting of the Patient Engagement Advisory Committee, also called the PEAC. I want to thank all the members of the advisory committee for their service, our CDRH team for their thoughtful planning, our speakers for sharing they're perspectives and members of the public who are attending this meeting.

Our focus for today's PEAC meeting is on the regulatory considerations for augmented reality and virtual reality devices or AR/VR devices. FDA has authorized several devices that utilize AR/VR technology for a wide range of uses including mental health, rehabilitation, diagnosis, and surgery. However, each one has different benefits and risks, and there are open questions about how to better communicate relevant information to patients and their caregivers. We look forward to hearing insights from our committee members, speakers, and the public during our 2-day discussion.

Now before we transition into addressing today's topic, I would like to share with you some updates on the work that's being performed by CDRH especially around patient science engagements and the use of digital health technologies. Many of you have seen this slide in presentations by me and others in CDRH. It is a constant because our vision is our North Star. Our vision is that patients in the U.S. have access to high quality, safe and effective medical devices with public health importance first in the world. First in the world being a good metric of timely patient access. And patient is a first word because they are our most important

customer and improving the health and the quality of life of patients including consumers is what our mission is about.

We look for opportunities to better understand patient perspectives about the medical devices they use as well as their needs, experiences, preferences, and concerns to inform improvements to existing devices and the development of new technologies that are fit for purpose. The benefits of hearing the patient voice, can be realized across the total product lifecycle of medical devices and across a range of diseases and conditions. We seek to bring the patient's voice into important CDRH activities such as medical device evaluation by engaging directly with patients as well as by encouraging the collection of structured well-defined evidence on their preferences, experiences, and the measurement of outcomes most important to them.

The PEAC has played an important role in furthering patient engagement in medical device clinical studies, and during the 2017 PEAC meeting committee members discussed and provided advice to FDA on the role of patient advisers in designing clinical investigations as well as identifying opportunities and barriers associated with involving them in the clinical study process. In a consensus statement the PEAC recommended that FDA develop a framework with input from the medical device industry as well as patients to clarify how patient advisers could engage in the clinical study process.

On January 26 of this year, after several iterations based on feedback from industry and public, FDA released a final guidance for patient engagement in the design and conduct of medical device clinical studies. During the FDA public webinar on this guidance, many patients and virtual audience raised their hands to be considered as potential patient advisers on medical device studies, a great testament to the work of this committee.

In clinical research studies sponsored by CDRH, we often include patients as advisers in the working group to help design the study and review the results. We encourage the medical device industry, academia, and others to do the same and seek opportunities to engage patients in their clinical study development process.

In addition to issuing the guidance, CDRH has engaged directly with patients through various mechanisms and venues. For example, we held a public workshop on study design considerations for a new technology to treat oligometastatic to the lung, a rare form of cancer. At this workshop patients shared their experiences living with this condition and how they considered trade-offs between benefits and risks of a new technology.

Understanding that a workshop does not always allow for fluid conversations, our patient science engagement staff have facilitated conversations among CDRH medical device teams and people living with difficult to treat, type two diabetes. These meetings are examples of the many conversations we have with people living with different medical conditions and using various medical devices. We also continue to participate in patient-led meetings at the request of patient organizations. These reciprocal exchanges provide patients with a deeper understanding of how important their voice is to FDA's regulatory work and ways they can share their insights with our staff. Both the workshop and these ongoing conversations helps inform FDA staff about patient's views on their conditions and the characteristics they value most for existing and future treatments in diagnostics.

By now all of you are familiar with our patient and caregiver connection, a network of partnerships with patient organizations. This important program provides readily available resource for our staff to learn from patients about their experiences with their medical conditions and the devices they use to manage them.

Presently the connection includes 19 partner organizations with patients and caregivers across a range of conditions that utilize a spectrum of devices overseen by all eight of our offices of health technology. We have received thousands of responses from patients through the patient caregiver connection on a variety of pressing medical device topics. We have leveraged these relationships to hear more about patient experiences with medical device recalls. This includes the ongoing Phillips Respironics recall which is improving millions of patients who rely on certain CPAP and BiPAP devices as well as ventilators. Through these conversations we gained insights on their experiences with the recalled devices as well as with the recall process. We also have the opportunity to hear their questions. As a direct result of these conversations, we have revised our communications to make them more understandable and to better answer the questions that patients as well as healthcare providers have about these recall devices.

As a keystone element of our ongoing efforts to incorporate the patient voice in our work, we are deeply committed to involving patients directly on the regulatory process through the Patient Engagement Advisory Committee. The members you will hear from over the next two days have discussed complex scientific issues during these meetings that have informed our regulatory efforts, ranging from clinical trials to patient generated health data to medical device cybersecurity, to artificial intelligence, including machine learning to medical device recall communications. And the advice from these advisory committee members have led to actions taken by FDA and others, as shown on this slide.

Last year the PEAC provided independent device about FDA and industry's approaches to communicating device recall information to patients. We have already begun putting that advice into practice. As I mentioned earlier, we are leveraging our partnerships with patient

organizations to help us develop recall communications that are clear, and address the questions and concerns patients have, and to help share the message more broadly to patients that use affected devices.

As mentioned by our PEAC members and the public attendees, the unique device identifier, also known as the UDI, could be helpful in the recall process. I'm happy to share that we successfully increased the inclusion of UDI in device recalls in our database from approximately 40% in 2021 to nearly 70% today. We're also exploring research to identify best practices and evidence-based approaches to further improve our communication on medical device recall information to patients, including consumers, and to identify optimal strategies for communicating action-oriented information across different types of medical devices.

Our commitment to patients is also exemplified by our exceeding to commitments we made during our patient engagement under the latest authorization of medical device use of amendments from MDUFA. Our CDRH staff has worked consistently and transparently to apply current practices in patient science, building capacity both internal and external CDRH, optimizing the research road map to help advance the use of patient science methods and fill gaps in measuring patient centered concepts and fostering a culture of meaningful patient engagement. Our effort to help expand the impact patients have on the evaluation of medical devices designed to diagnose and treat them. It was because of the great work of our staff across the center, and the contributions of many of you that laid such a solid foundation for the next round of MDUFA negotiations.

Throughout the MDUFA five negotiation process, we engaged extensively with patients including consumers and other stakeholders. Beginning in October 2020 we hosted a public meeting to share CDRH's performance on all our MDUFA four commitments and to gather

public feedback on how best to improve and build on the program. We then met monthly with representatives of patient consumer healthcare professionals and scientific organizations to share updates from the negotiations and to dialogue on a wide range of topics. This engagement helped Shape what FDA proposed to the industry. We also shared with industry the feedback we received from these stakeholder sessions. We concluded our negotiations this April, with a final public meeting resulting in a negotiated set of recommendations for the industry that reflected the rich feedback we received. The recommendations presented to Congress underscore the continued commitment by the FDA and medical device industry to enhance innovation, premarket safety, and timely patient access to safe and effective medical devices. We hope in the future the scope of MDUFA will be expanded to include post market safety as is the case in our drug program. We made significant strides to meet the strategic goals we set in 2018. Our focus on our people, customer service, process improvements and organizational Quality Management allowed us to instill a culture of collaboration, quality, and continual improvement across the center. In particular our priority of collaborative communities specifically included patients as important stakeholder to participate in these communities as members, and with equal voice to FDA, healthcare providers and industry. So far, we participate in 12 collaborative communities and are about to join another one. We accomplished so much because of the dedication, expertise and innovative spirit of our staff, the reason behind our current and future successes. We have already put many of the key programmatic policy and process enhancements in place to achieve our vision in the next few years. Therefore in 2022 to 2025 we will continue to focus our efforts on ensuring our workforce and organization are well positioned to full a achieve and main tear our vision for all patients. In addition, advancing health equity is one of our strategic priorities that recognizes

CDRH can and will take actions to advance the development of safe and effective technologies to meet the needs of all patients. We are working to help realize a vision where patients from diverse backgrounds are included in the development and evaluation of emerging technologies. We are also working to help bring these technologies into the home, thereby extending care to more populations and potentially reducing healthcare costs. Clear accessible and interpretable information about the safe and effective use of medical devices offers promise in the care of many conditions and should be designed for all and available to all patients regardless of their background.

Putting patients first is an empty promise if it only applies to some and not all. No patient should be left behind in healthcare. And CDRH is committed to doing its part. The strategic priority of advancing health equity also highlights the important role of digital health technologies play in helping reach the national goal of equitable health outcomes because technology can help bring preventative screening, diagnostic monitoring, and treatment capabilities into the home setting while facilitating patient participation in clinical studies. Anticipating the promise of these new technologies hold, CDRH launched the Digital Health Center of Excellence which we announced at a PEAC meeting two years ago. The center was established to help FDA address growing public health needs and opportunities in the digital health space. FDA's efforts to date have identified new paths forward for novel technologies, improve regulatory clarity, and international harmonization, and provided patients with access to novel, safe and effective digital health devices for numerous conditions. However, there are many important issues that still need to be addressed to assure emerging digital health technologies are safe and effective and meet patient's needs.

That brings us back to the topic for the meeting today, the use of augmented and virtual

reality also called AR/VR, medical devices. During the next two days you'll hear from the FDA about the regulatory considerations for these devices. You'll also hear perspectives from medical device industry, academia, healthcare providers and patients. And in a popular feature that has been the custom of the PEAC meetings, patients have the opportunity to dialogue in roundtable breakout sessions later today to work through a hypothetical scenario. This scenario asks you to put yourselves in the shoes of someone who is considering the use of an AR/VR device in the treatment of themself or their loved one. There is growing interest in the area of AR/VR, and we are increasingly seeing innovative devices with these capabilities that have the potential to improve patients' lives. We look forward to the discussion and advice from the PEAC members on the use of AR/VR devices including in children and other medically vulnerable medical populations. Thank you for your time and attention again to all of you, for your participation. With that I'll turn it back over to the chair of the advisory committee, Mr. Paul Conway. Thank you.

MR. CONWAY: Thank you very much, Doctor, Dr. Shuren. Thank you for your leadership and commitment to the patient safety and patient engagement. We appreciate it and respect your efforts. Thank you very much. It's now just about 10:50 a.m. and we will go ahead and proceed with FDA's presentations.

I will remind public observers at this meeting, that while the meeting is open for public observation, public attendees may not participate except at the specific request of the Chair. FDA will have 10 minutes to present.

FDA will start their presentation with an overview on Augmented Reality and Virtual Reality Medical Devices by Dr. Leeda Rashid. Dr. Rashid, you may now begin your presentation.

DR. RASHID: Thank you all for joining us today. My name is Leeda Rashid. I'm a

physician at the Digital Health Center of Excellence at the Center for Devices and Radiological Health. Digital health technologies can transform healthcare and improve patients' lives. The emerging scientific and technological advancements of augmented and virtual reality in particular can span across the entirety of the patient's healthcare journey from prevention, diagnosis and treatment, including surgical needs as well as rehabilitation.

Today we will be discussing many of the technology and regulatory challenges of AR/VR devices. We will briefly discuss working definitions of AR/VR for the purposes of this meeting as well as summarize some of the benefits and risks and the regulatory considerations for assuring these devices are safe and effective for patients.

For the purpose of this meeting VR can be thought of as a virtual world experience that may require a headset to completely replace a user's surrounding view with a simulated, immersive and interactive virtual environment. AR is defined as real world augmented experience imagery with the real world as seen through a camera or display such as a Smartphone or a head mounded or heads up display. Digital imagery may be able interact with real surroundings often controlled by users. AR/VR requires hardware and software that are unique to AR/VR and highly sophisticated. What's more, the hardware and software must work together seamlessly in order to provide the type of immersive, controllable and consistent experience that is important to most medical applications as well as to minimize discomfort and other undesirable benefits.

AR/VR technologies are already in use by healthcare providers in many settings, including for medical education and maintenance of skills, mental health disorders and preoperative planning and for visualization during procedures. They are also being used increasingly at the point of care and in the home by both patients and caregivers.

Current and future applications include vision assessment, para visual disorders, chronic pain management, among others. Benefits of AR/VR devices may include improved surgical planning and procedures, adherence to treatment and adjunct treatments for health conditions. The breath of applications you will hear about today speak to the possibility of AR/VR to help shift care to the home and improve access to diagnostics and treatments.

There are however potential risks associated with the use of AR/VR. Because the technology has not been in widespread use until relatively resent the extent, nature and duration of these risks may not be fully understood. It is likely that other, not as yet identified risks, will emerge. Some current known risks include cyber sickness, dilutions and falls, fatigue, visual disturbances, information overload and feelings of disassociation from reality, seizures, and privacy violations, among others. The risks may be magnified in clinical applications both because they are even less well established in clinical context along with the potential vulnerabilities when a device is used by non-clinicians and in cases where the patients also directly used the device. The voice of the patient therefore is paramount to understanding the occurrence and importance of these factors particularly when the technology is advancing quickly, and research is ongoing.

There are a number of populations where the use of these devices may raise special concerns. As an example, even the greater brain plasticity and continuing brain development in children, the impact of AR/VR on the developing brain deserves special attention. In the cognitively impaired population, users may require a mode of AR/VR that minimizes demands on cognition, memory, and language skills. Furthermore, some users with certain mental health conditions may also require special accommodations, for example, individuals who experience dissociative space, hallucinations, or other difficulties where perceiving reality may

be frightened, confused, or agitated by virtual content.

For surgeons using AR devices, even minor adverse (indiscernible) Including fatigue, disorientation and misjudgment of distance could impact surgical outcomes. And finally, socioeconomically vulnerable, and underserved communities may lack equitable access to AR and VR based care. Individuals may not have the resources to buy consumer AR/VR headsets that might be needed to run medical care applications or they may lack high speed internet and open floor space required to operate AR/VR devices safely and effectively.

As part of FDA's premarket review, the agency weighs the benefits using the medical device against any risks. Based on its analysis, FDA then makes a decision about whether a device can be legally marketed, and if manufacturers are able to provide robust data to demonstrate substantial equivalence in a 510 (k) submission or reasonable assurances of the safety and effectiveness in a de novo request.

When making authorization determinations, FDA considers the totality of the evidence including bench testing, clinical testing, real world evidence and human factors in usability assessments. Human factor studies in understanding how patients actually use AR/VR devices can be particularly relevant to technology such as AR/VR to mitigate errors in use. In reviewing benefits and risks, FDA also considers additional evidence including patient preference information, uncertainty, and whether the device fulfills an unmet market need.

Labeling is information provided to help patients and healthcare providers understand how to use the device as well as provide safety information. This can include training on how to use the device and information on risks and benefits. Labeling requirements also ensure that the agency is able to further mitigate risks posed while using AR/VR devices.

Most market surveillance of medical devices ensures the devices on the market are

operating safely and effectively in the real world. The FDA uses a variety of methods to monitor the safety of the device after it is on the market including post market studies, medical device reports, inspections, recalls, active surveillance of certain devices and ongoing research and data analysis of medical journals, electronic health record systems, patient registries and administrative and insurance claims.

If any health risks are identified, FDA may request the device manufactures to update the device labeling, to recall the device, to further study the divide while on the market or to submit a premarket submission if the device is significantly modified. This is especially important in AR/VR devices where regular software updates may be a consideration.

The agency may assess the impact of special factors particularly relevant to AR/VR safety and effectiveness. Some of these may be how device software functions are used with consumer product hardware and software since many AR/VR medical applications are being built on or integrated with consumer hardware and software. As such, FDA may assess the impact of these off the shelf device to safety and effectiveness of the device function. Other special considerations may be for populations who use these devices like children, the elderly and people living with disabilities. Manufactures often recommend head mounted displays be used in persons over the age of 12 or 13 but medical applications may include children younger as well.

Of particular importance is the patient's ability to make an informed decision and participate in the AR/VR medical trials as well as using these devices in clinical care. As mentioned earlier, FDA will typically mandate that labeling be provided with the device. While labeling may be necessary to understand how to use the device, labeling may not completely mitigate the risks of device use. Given the many unique combinations between hardware and

software and AR/VR devices the FDA may consider labeling information regarding the use and modalities of training needed to use the AR/VR devices.

In conclusion, the agency is committed to helping advance those technologies that meet patient's needs in a safe, effective, and equitable manner. We look forward to learning from you today about how we might best fulfill that commitment. Thank you.

MR. CONWAY: Thank you very much, Dr. Rashid. Now I will go ahead and proceed with the presentation by Dr. Walter Greenleaf, a healthcare researcher from Stanford University in his presentation entitled A General Overview on AR/VR Healthcare- What it is? How is it used? And what's the difference? He'll be followed by an industry perspective presentation on Developing AR Medical Devices for the surgical field by Dr. Jennifer Silva, from Excera and Sentiar. You'll each have ten minutes to present. You may now go ahead and start your presentations. Thank you.

DR. GREENLEAF: : Hello. I'm Walter Greenleaf. I'm a neuroscientist and medical virtual reality expert who works at the Stanford University Virtual Human Interaction Lab. I'm very excited to be speaking with you today. During this presentation I will provide an overview of how VR technology fits into the digital health ecosystem and also provide specific examples of how VR systems are currently being used clinically. Recent changes and costs and access to VR technology now make clinical VR systems affordable and available. It's an exciting time for those of us who have been working in the field. After more than three decades of conducting research, development and clinical studies, virtual reality and augmented reality systems are moving out from the research arena and are being deployed in clinical care.

Before getting into specifics, we need to spend a moment discussing terminology. During the course of this meeting the terms VR, AR, MR and XR will be used. Although the exact

nomenclature is still evolving, just as the technology is evolving. Those are the four terms that are in common use today, VR, AR, MR, and XR. Virtual Reality, VR is the term most commonly used to describe fully immersive systems. This is when the user wears a headset that blocks out their view of the external world. Augmented Reality, AR, refers to systems that overlays our view of the world with extra information, a form of heads-up display. Mixed Reality, MR, refers to augmented reality systems that are also interactive and dynamic. The user can interact with the information deployed. It's worth noting that mixed reality environments can be shared with other people. This is useful when collaborating on a project or learning to work together as a team.

Taken together these systems are called XR, or Extended Reality systems. The term Immersive Systems is also used to describe VR, AR, and MR systems because the term immersive implies a spectrum of immersion. All sectors of healthcare are exploring the use of VR technology. The general spectrums include clinical training, clinical assessments, interventions, telemedicine platforms and systems to promote preventive health and wellness.

As you are probably aware we are in the early phase of a digital health revolution. New systems are being developed to make use of mobile and computer technology. As digital healthcare systems move forward, they serve as a solid foundation to deploy clinical virtual reality technology. It's important to note that VR and AR technology is also evolving in a very rapid pace. There are substantial improvements every year. One example of recent improvements is the introduction of a new sensory component that can be added to a VR system. Various odors, smells both pleasant and unpleasant, can now be part of a virtual reality experience. This adds yet another layer of real risk to virtual reality experiences. Other improvements include the way virtual reality avatars and virtual human systems are becoming

much more life-like. The incorporation of realistic and appropriate facial expressions into our virtual avatars. This along with other nonverbal communications, signals such as gestures and body language can enforce user's mood and communicate mood and intent.

As 5G systems evolve, we will have the ability to render high resolution graphics and render the data at the edge to provide robust virtual world systems. We are leveraging cloud-based rendering to provide for multi-use virtual worlds for great fidelity approaching photo realistic.

It is important to note that VR technology is not a recent invention. The first commercially available systems were developed in the late 1980s even though these early systems were expensive and sometimes uncomfortable they inspired a forward-thinking group of research scientists and academic leaders to focus and dedicate their career path on exploring and developing clinical VR systems. As a result of the hard work of these early pioneers we now have a foundation of more than 3,000 research publications exploring and elaborating the challenges and the advantages of VR and AR technology as applied to clinical care.

We can also see the application of academic work focusing on clinical VR in the more than 300 clinical products that incorporated VR technology. Immersive VR systems are now very compelling and cognitively engaging. In healthcare they provide a new and effective mechanism of action. Properly designed XR systems provide a method to improve adherence to clinical protocol, improved engagements and improved clinical results both diagnostically and therapeutically.

Here are some of the mechanisms of action provided an AR/VR and AR technology. (Indiscernible) systems generate improved (indiscernible) presence and underscore the appropriate therapeutic context. Immersive systems are captivating and emotionally

rewarding. We utilize techniques from gaming industries to promote deeper patient cognitive engagement and to sustain greater clinical adherence through experiential learning retention and learning are dramatically increased. There are many millions of XR systems are used in healthcare.

At the top of the list are the systems that improve clinical training. XR systems facilitate experiential learning. They are used to very effectively enhance medication rendering from clinical and surgical skill training, to training on the use of complex medical equipment. XR simulations are also used for team training ranging from emergency departments to hospital wide emergency response training and scenario rehearsal. Because mistakes are free in virtual environments, it is possible for learners to repeat and rehearse procedures at their own pace and to develop a strong repertoire of clinical skills.

VR simulations are used to train medical students and staff to respond to high stakes low frequency emergencies and at the Children's Hospital in Los Angeles, for example, the training in pediatric resuscitation is required for incoming students and staff. Simulated patients encounters provide a robust method for learners to develop and hone both technical and interpersonal skills.

The next sector of VR and AR technology is providing more objective clinical assessments by measuring functional movement, simulations of daily activity can provide a quantitative evaluation of a patient's ability to live independently. By providing brief producible cognitive and emotional challenges in a way that is deeply engaging VR facilitated assessments provide more objective measurements of cognitive function, intention, and emotional regulation abilities. Robust and reproducible assessments are a critical tool in psychological and psychiatric care.

One example of this approach is the score of cognitive load generated by the sensors embedded in the Hewlett-Packard omni-set VR headset. The next sector of VR applications is to improve clinical interventions. One powerful example are the VR and AR systems that are used for preoperative planning and image guided surgery. The assistance makes it possible for a neurosurgeon, for example, to plan their surgical approach to removing a tumor in advance to share the plan with the patient and – trade-offs in a way that includes patient understanding. During the surgical procedure it is possible to overlay the operating field with the surgical plan and to dynamically register and identify key features using AR technology. XR systems provide new and powerful ways to treat stroke and traumatic brain injuries and other clinical conditions in the field of physical medicine, occupational therapy, and rehabilitation.

As we all know, there is an urgent need for new approaches to mental healthcare. Virtual environments are used clinically to treat many mental and behavioral health problems. Examples include anxiety disorders such as posttraumatic stress, phobias, social anxiety. XR systems are also used to address problems such as addiction, depression, chronic pain, autism spectrum disorders, attention deficit disorder, obsessive compulsive disorders, psychosis, just to name a few examples in the field of mental healthcare. Posttraumatic stress phobias and anxiety disorders are treating using VR systems by facilitating exposure therapy on demand. XR systems are used to support therapy for addictions by facilitating refusal skill training and practice, risk avoidance training and also situational confidence training.

XR systems are also used as part of health and wellness care. Examples include systems to promote healthy behavior such as exercise and weight management. There are also systems used to address stress and worries to improve mood and to teach resilience skills. During this time of COVID VR systems have been used to connect family members and to address senior

isolation.

In summary it is an exciting time to see the various ways XR, AR and MR technologies are improving healthcare. Virtual and augmented reality are moving out from the research lab and into clinical care. Recent changes and costs and access make clinical VR systems affordable and accessible. After decades of study and use by early adopters clinical validations systems are moving into mainstream care.

It has been my pleasure to share with you this general understanding and my overall positive perspective regarding the various ways that virtual technologies will improve and include clinical care. Thank you for your attention.

DR. SILVA: Hello. My name is Jennifer Silva and it's my pleasure to be here today to discuss the development of medical extended reality devices from the perspective of the sponsor.

As I said, my name is Jennifer Silva. I am the cofounder and co-inventor for the technologies that have been developed into Sentiar and Excera. In addition, I'm a professor of Pediatric and Biomedical Engineering at the Washington University in St. Louis.

For those of us who develop any medical device, there is a pattern of events that always start or should always start with addressing an unmet need or an unarticulated need. What do we need during the practice of medicine that can be enhanced, enabled, augmented, better through the development of a medical device? What's interesting here is that we must always ask ourselves once you've crystallized what the unmet need is, is what is the correct type or is medical extended reality the correct type of enabling technology for the project that you are undertaking to address your need? If you do think that medical extended reality is correct, then what type of MXR would be appropriate?

Let me identify a problem that I fixed clinically in my practice as a pediatric electrophysiologist.

I do procedures on children who have hard resilient abnormalities. This picture here is a picture of my current electrophysiology laboratory. What you see is a series of screens that provide different data sources of the procedure simultaneously and require me to take these various data streams and to put them together and to come up with a single mental model of what's happening.

You can clearly see by the four screens on the left, the two by two, that the visualization is really quite rudimentary. And control of the data is limited as I'm standing at the table with a catheter in my hands and require people standing at various workstations to make measurements or to do other maneuvers to me as I'm standing at the bedside. So, my problem in interventional VP is both visualization and control.

We developed the command EP application. This is version one, an FDA cleared application. What our system does is take data from a commercially available electro anatomic mapping system, partner with those companies, and then take our platform which is enabled on a head mounded display seen here and then displays a real patient specific three-dimensional hologram with real time catheter locations while we're doing the procedure itself.

Also, this allows us to give physicians control of that model and manipulate it so they can turn it, rotate it exactly what they need to do to understand precise anatomic relationships for that particular patient.

Lastly, we provide the ability to connect multiple data sources, allowing for collaboration. What we've done is provide a platform that we hope will expand for the entire procedure. Let's

take a look at what the system would look like. The SentiAR system is worn, the commanding system is worn at the beginning of the procedure and the (indiscernible) puts the headset on their head. Once they're in there is this is a gaze-based control system. You see the little white circle acts as your curser and allows you to select items at the menu as a stare at them. You can position the hologram wherever in the workspace you like. And once it's there it's an anchored model in your space and you can look around the corner at it. You can also clip into it. The clipping plane is simply your face. As you move in towards it, you can clip into the model, and you can see inside the model or inside the heart.

Importantly, we can create shared sessions where up to five users can be in a single session and have a student teacher mode where one person is teaching the other passive onlookers as to what they should look at and how they should interpret it.

You can rotate the model however you choose using this ring model where you just push on it however you like, or you have these pre-set views. We tend to use these typically in the laboratories, fixed use for the model. You can Zoom the model up to be as big as you want, you can stand in it if you would like. And then lastly you can change the opacity of the model, make it brighter or dimmer and this depends on the lighting conditions that we have in the room at any given time.

So, what were the lessons that he with learned during development? And I've been using these as the four big lessons. The first is the digital space. As you notice from the video digital space, or the field of view where you can have digital tools, the menu, the model, et cetera, for us it was important that that be uncluttered, that it allow you to see through the headset itself so you could still be present in the lab, in the space with your patients, with your colleagues, with your team. You weren't blocked and cut off from it. It also had to be not distraction so

keeping these things clean and simple was very important. The user interface, as you noted also in the video, there was no hand motions, no pointing and clicking with your fingers. You will also notice there was no voice commands that were delivered. We decided, after deep human factored testing that it was important for the user interface to be a gaze-based interface. That allows the physician to have their hands on their tools so they can do what they need to do as they're going through the procedure. And importantly, in the cardiac physiological laboratory that's sort of a noisy space with lots of alarms and bells and people chattering so voice control really did not seem to work well in that space either. We talk about the user experience. It was important that the user saw that this was an intuitive experience that they didn't really have to work hard to understand what they wanted to do. The things, the way they interacted with the model, the things that they wanted it to do were easily done.

And lastly, technical specifications. I'm not going to get into that today. That is a bit beyond the scope of what we're talking about. But it is safe to say there are clear technical specifications that these medical extended reality devices should meet, and this is ongoing work between the FDA and medical device engagement consortiums that we're also participating in.

What were some lessons we learned from our clinical study? Well certainly it's important to understand the system usability. And often that system usability is a clinical or other healthcare provider facing outcome measure. How did they feel when they used the tool? Was it easy to help? Did it feel like it helped them do the procedure? Did they feel like they were better able to perform their work? But another thing that is really critically important we think about are outcomes. We have to identify patient-facing outcomes. That’s really quite key in all of this. And we should be creative in thinking about outcomes that may be meaningfully

impactful to patients. We should also find outcomes that are discreet and are measurable. And it may be of interest to talk to patients and see if they can help sponsors and investors understand what those patient-facing outcomes may be.

So, what are some considerations for patient consent in clinical studies for emerging technologies? Well, there certainly are some general considerations. First, I think it's very important to allow plenty of time for discussion with patients and their families. When SentiAR did their clinical study, we found that it was very important to contact patients and families at least a few weeks in advance of their procedure and study. This allowed patients and their family the time to think about and talk about it as a family and then to reach back out with any questions or concerns that they had. Also, it's important that investigators and sponsors answer the questions as clearly and honestly as possible. Lastly, I think it's important to show patients what did the technology look like? The fact of the matter is that we all have our own biases toward virtual, augmented reality and mixed reality and the ability to look at the technologies, to look at the devices themselves can help us break some of that down. Are there unique considerations for a vulnerable population? Absolutely. Here more so than most, seeing really is believing and it was incredibly important for us when we were doing our clinical study to show patients what the technology looked like. Now we actually went one step further. Once patients and families had completed their consent and assent then we allowed them to have a device demonstration. Why did we wait until after consent and assent had been completed? We wanted to avoid even the appearance of coercion. However, the ability to show patients and their families what the technology looked like and experience it themselves was really important in our process.

SentiAR believes that preferrable MXR applications can have an important impact on

patient engagement and understanding of their disease process, procedural consent, and pre and post procedural education.

So, I would like to show you these two pictures. These are two patients that were enrolled in SantiAR's pair study, which was their cardiac augmented reality and collect physiology study.

The young lady over here on the left was actually our first patient enrolled in the study and you can see the smile on her face. And let me tell you why she's smiling. One, she intuitively understood it. She absolutely got it. But two, she was even more excited that a woman had been involved in inventing and founding this technology and it actually set her down a different career path where they thought that she, as a woman, could proceed to further her education in STEM subjects and now I'm grateful to say that she is in college and studying engineering and I couldn't be prouder of this young lady.

Take this little boy to her -- just on the right-hand side here. You can see that he's actually got his iPad on his lap and is wearing a headset and going through it. And what was remarkable about this young man is that he is also a diabetic. What he told me in the midst of undergoing his IV and looking at the demo was, "Hey Dr. Silva, there's so much that we can do with this to help other kids with diabetes." And I thought to myself, we're in good hands. The next generation's going to do an amazing job with these kinds of technologies in healthcare.

I would like to thank my team at SentiAR and at Washington University and St. Louis Children's Hospital and all of other wonderful collaborators for the ability to be with you here today and to share our thoughts on medical extended reality device development. Thank you so much. Have a wonderful meeting.

MR. CONWAY: I would like to go ahead and thank Drs. Greenleaf and Dr. Silva for their

presentations. We will now go ahead and proceed with a ten-minute break. It's just about 11:23. I'll ask committee members to not discuss the meeting topic during the break among yourself or with any other virtual member of the audience.

The meeting will reconvene in this room at 11:33 A.M. At that time, we will continue with presentations, hearing from industry, a healthcare researcher, healthcare provider and a patient. So again if you can reconvene here at 11:33 that would be great. Thank you.

[Break]

We will now proceed with a presentation about Industry Perspectives on Designing Immersive Therapeutics (ITx) for self-directed, At-Home Use by Mr. Josh Sackman from AppliedVR. Followed by the Healthcare Provider Perspectives on Pediatric Users as a Special Population for VR Consideration from Drs. Jeffery Gold and Juan Espinoza from Children's Hospital Los Angeles. These talks will be followed by a Healthcare Researcher's Perspective on the Use of VR in Other Vulnerable Populations and Health Equity Considerations from Dr. Courtney Lyles from University of California, San Francisco, and a Patient Perspective on The Experiences of Using VR in a Healthcare Journey from Mr. Sharif Razzaque. You each have10-minutes for your presentations. You may now begin your presentations now. Thank you.

MR. SACKMAN: Hi, I'm Josh Sackman. I'm the president and co-founder of AppliedVR. Today we're going to talk about our experience and lessons designing immersive therapeutics for self-administered at home use. When I first came across virtual reality in 2014, I was blown away that there are 20 plus years of academic research demonstrating that the immersive communities of virtual reality can transform human behavior in ways that I've never seen other

technologies do. But I beg the question, if virtual reality is so powerful, why hadn't I heard of this? Why hadn't others? Why don't I see this in the real world? And that's when I learned that a lot of great innovation is born, but also dies in laboratories because those concepts aren't designed and product ties for use in the real world. Today we'll talk about our experience taking those concepts from the laboratory into the real world and some of the factors that we see for the success and broad adoption of immersive therapeutics.

First, I wanted to highlight healthcare inequities and gaps in care of exacerbating the massive chronic pain epidemic. This is true for other chronic illnesses as well depending on who you are, and where you live there may be one specialized provider for 30,000 to 60,000 patients. And highly advanced in things like telemedicine have done amazing things to close that gap, it still requires a trained professional on the other end of the line that's available to treat you and there's a growing HCP shortage. The supply is shrinking. In 2021 alone 700,000 HCPs exited the market and Mercer predicts a shortage of 3.2 million healthcare workers by 2026 that's where we see so much promise in the self-administered care model to increase access, to be able to provide convenience at home, special psychological based therapies, there’s still a lot of stigmas and things that hold people back from seeing a therapist and get the care and treatment needed. Self-administered care in the home allows people to access treatment when they want it on their own terms, and it also starts setting up this infrastructure for scale. As we think about these treatment offerings we need a factor in the regulatory pathways, reimbursement pathways and the broader patient support ecosystem so today we'll cover each of these three components as we think about building this out.

Now it's really easy to think of VR as what you see in the headset as the content and software, but the reality is you think about bringing virtual reality therapeutics into the home,

you have to think about it more holistically. You bring the physical device into a patient's home with preexisting health conditions. These are not your typical virtual reality users. We need to think about what the experience is, taking the device out of the box. We thought through a gaze-based interface to allow someone who is not comfortable with a remote control. We subject the devices to the same interactive testing following IEC 60601 standards to make sure this doesn't interfere with pacemakers and other medical equipment.

When AppliedVR took our product through, took Reliever through the FDA pathway back in 2021, we got regulated as a class two SiMD software in a medical device taking a look at the software and hardware components because it's really critical. As well as factoring things in like cybersecurity, HIPAA and high trust are really critical to be able to trust the system, so I really encourage people to think about when it comes to design and you know driving adoption of something new, think about the whole ecosystem and the product really holistically.

As we think about driving acceptance and adoption of virtual reality in the real world it takes a number of different methodologies to understand what's working and what's not. We started out with user research, with structured interviews. We evolved to setting up the devices in the home. We even conducted video blocks through ethnographic research where we could see the unboxing and patients could share their experience with us and we completed the gold standard RCTs for FDA, double-blind, sham controlled, understanding how the product is used, looking at objective data, patient reporter outcomes and other reported measures and now we're even looking at claims data to understand what this looks like in pharmacy and medical claims data.

And ultimately, we decided, as we think about building out products, we have defined our 3 Es of product design. In order for virtual reality therapies to be largely accepted they need to

be efficacious, easy to use and engaging. In our pivotal trial among 188 participants with chronic low back pain, we look a look at baselines measures, at their pain intensity and pain interfering with sleep, mood, and stress.

At the end of eight weeks we saw that participants experienced 42% less pain and between 49 and 57% reductions in pain interference with activity, sleep, mood and stress and we shared that to a sham control where patients use the same headset, but using content that was in 2D without therapeutic qualities to it, but it still accounted for the ritual of putting on a headset, and we saw both clinically meaningful, and statistically meaningful results but we didn't stop there. We looked six months post treatment to see what happened after the device was returned after they were off treatment and saw patients had durable results. They sustained 30% or greater improvements from baseline across all five of those primary inputs. We took a very robust look at the impact of these therapies.

In addition, we used the STEM usability score in order to assess how easy this was to use. This was a standardized and validated instrument that has a number of benchmarks with all the common consumer technologies that we use, and people found our product reliever easier to use than Gmail, Amazon, iPhone. And we took a look at the usage on the device and found that participants used the device 5.4 sessions per week, and roughly 90% of patients completed the trial. In a world where 30 to 50% drop out of the chronic pain trial, isn't too uncommon and so you need to look through a broad filter, looking across all three dimensions and using those methodologists on the former slide.

You don't get there overnight, we certainly weren't an A+ in usability three years ago, but we got there through iteration and constant product development and validation cycles. I'll spend a brief amount of time here, and it's not one type of evidence and one design

consideration because there's so many different stakeholders in healthcare, and so you need to think through the evidence requirements across patients, providers, payers and policy makers. Because this is an FDA organized workshop I will highlight, oftentimes it's easy to neglect the needs of policy makers, but CMS and FDA are such key drivers of the awareness, accepting and adoption of new technologies in medicine. As well there's a pretty comprehensive list of medical device requirements from a policy perspective when you think about quality, cybersecurity and things like that.

And ultimately where this culminates, our vision is that there's a VR pharmacy in every home. Virtual reality has so much promise to deliver value across pain, behavioral and mental health conditions. For right now if a person had four different VR treatments, they likely would have four VR headsets. There needs to be a platform in order to deliver multiple therapies and to provide easy access in every home. Virtual reality tends to be a pretty isolated experience as one person goes through their journey in the headset, but VR inherently has the ability to connect at a deep emotional level. Through that we can create peer support and connections that bring people together through their headsets to be able to support each other and facilitate meaningful changes and build communities.

And lastly, as we have big enough datasets, it's not one size fits all with any course of treatment. We have the ability to be able to personalize and offer precision VRx. Virtual reality has so much promise, but it really takes considerations across designing to make sure this can be accessed and used and useful for a broad group of people across the world. I look forward to answering any questions that you may have. Thank you.

DR. ESPINOZA: Hello, everyone, my name is Juan Espinoza and I'm an assistant professor at Children's Hospital in Los Angeles, and director of the West Coast Consortium for Technology

Innovation.

DR. GOLD: Good morning, good afternoon, everybody. Dr. Jeffrey Gold. I am a PI for a biobehavioral pain lab. Professor of Anesthesia Pediatrics & Psychiatry at the Keck School of Medicine and also at Children's Hospital in Los Angeles.

These are our disclosures. And none of our potential or foreseeable conflicts of interest or disclosures have any role in what we'll be discussing today. First, we thought we would start with just laying out the framework we're going to use the term "extended reality" which you may or may not be familiar with. Extended reality refers to a spectrum of technologies that we sometimes use. We've heard about virtual reality which is a fully immersive environment so you may have done it yourself where you're wearing a full headset, you're in a digital experience.

Mixed reality is where there are digital elements that can interact with physical elements. And then augmented reality is a digital layer over physical activities, over physical elements. So, the classic element of augmented reality is Pokémon GO where you use your phone to see digitals things that are not actually interacting with the physical environment.

So, when we think about this range of technology, spectrum of technologies depending on how they're being used and why, they may or may not be regulated by the FDA. So, all the way on the left here you have the sort of unregulated use, so it's the entertainment distraction, right? Someone has an ocular headset at home, for example, and pick a brand and they use VR, and you go somewhere and -- with the VR or you play a game on your phone.

Then there's education, training, and preparation. So, we see uses for this in healthcare sometimes like helping patients prepare for a procedure or to teach a physician how to perform a procedure. Then you start getting into more firmly – things that are in the device space sort

of regulatable space, like biofeedback, using sensors to measure things like heart rate or skin response or other elements about the body, using that to change or alter the VR experience back and forth. And then finally actual true therapeutic or diagnostic applications, so these are cases where the extended reality or the VR is itself the treatment or the diagnosis. And so, the thing to remember here, what's critical is how it's being used and why it's being used because the exact same physical piece of hardware might be in an unregulated or regulated space depending on what's being done.

And then finally we want to talk a little bit about pediatric specific considerations. So of course, there are some general considerations about VR. Some people experience dizziness when they're wearing their headsets or in immersive environments so there's some general considerations that are true for all the users.

But when you think about children using VR, we would like to group them roughly into these four categories. So, the first I'll start with is data and privacy. So, for children you know if you're using a VR, AR, MR, if you're in extended reality it's not just the hardware – the visor or the headset or the controllers. There's almost always – there is also software, and that software is often connected to the internet and often requires and account, and the account requires collection of data. In the United States collection of data for children under the age of 13 is regulated by COPPA, Children's online Privacy Protection Rule, so there are specific requirements on how that is handled and so if a child is using VR and it requires that data collection, and there are additional implications to that.

>> I'll just chime in for us a lot of the studies we've done at Children's for the last 20 years would have a headset that would not be connected necessarily to Wi-Fi, the internet and all of the applications and software and experiences would all be loaded to the hard drive of

that actual particular device so that we wouldn't have any of those types of issues of data privacy or breaches of privacy or confidentiality, just keeping it local to that particular headset so there are ways to control for that when you're designing research and you're deploying this type of technology specifically around children so that's a very sensitive area.

>> Yeah, that's perfect. And so important to know that -- for people to know that there are safe ways to do this.

The next area is what I'll call sort of physical and mechanical considerations. So, this is just, this is more you know does the headset fit? Is it too big? Is it too heavy? Children are smaller. They may not have the neck support or the neck strength to hold these larger headsets so there are some very real considerations for how does a smaller person use these devices that many times they're designed for agility.

>> Right. And that's also true for the clinical application. Sometimes your healthcare provider, a nurse, a physician, a phlebotomist may need to talk with the patient and whatnot, so having their ears occluded with headphones, not being able to see their eyes. For example, with the anesthesiologist (indiscernible) being able to actually see their eyes and see if they're sedated or et cetera. The size, also we have kids who sometimes will tear up during procedures and then it all fogs out and so these are all the kinds of things you need to consider when you're doing VR research or AR research is ways in which it fits, is it comfortable, can they communicate with their healthcare providers, can the healthcare providers communicate with them and are they having really the full experience as opposed to really having lots of device issues and physical limitations. As Dr. Espinoza, said if it's too big and it's slipping down all the time on the kid's face that's not really a good fit for them so you have to make sure they're well fitted and can be physically comfortable and also have that experience in the VR space.

>> Yeah. And in recent years some manufactures have developed headsets specifically for younger and younger children, so this is something that's being addressed now also by the manufacturers themselves.

>> Yep.

>> The third category here is machine-brain interface. So, this comes up the most in VR in headsets. And the machine brain interface here is quite literally the eyes. The eyes are what's interacting directly with the machine and there has been some concern in the past about the improve of VR and just the way that we're delivering information to the eyes and what impact that might have on eye quite literally allergen on eyeballs and the digital pathway. There's been research to so those very little concern, but this is something that's been around for a very long time.

And so, it's important to be aware of the concerns but also to be aware of the data showing that it is actually safe.

And a lot of times with our protocols, again in pediatrics we'll exclude children who have eye related issues or there's concerns about seizure activity or anything that could potentially trigger in a VR experience in the child, or to have some sort of negative effect from the VR so we're always doing very rigorous research and having inclusion/exclusion criteria that define these exact issues that Dr. Espinoza talked about which is being sensitive to the eye system and making sure it's safe you know for that child so again the data – is it you're excluding these children we're not really collecting data per se on kids who have seizure disorders because we're excluding them right now to make sure that they remain safe and without side effects.

>> Thanks. And then our last bucket is our neurodevelopmental considerations so what we mean by that is the child developmentally appropriate to use VR. And this one is probably

one of the from a pediatric -- is most unique for pediatrics. It's something that comes up in all aspects of pediatrics but are they allied enough to interact with the machine or the software. Is the content that is being exposed -- that they're being exposed to developmentally appropriate the same way we think about books and TV shows and toys and experiences being appropriate for children, is this VR experience also appropriate for a 4-year-old or a 7-year-old or a 12-year-old.

So that's really important. And one thing that I think parents sort of have asked me in my clinical practice is screen time. We always say the American Academy of Pediatrics recommend children under two have less than about two hours of screen time and I think what's important here to think about is what is the purpose of the screen. And if this is VR or extended reality being used for a therapeutic purpose then the screen time rules – we are talking about passive, noninteractive sort of the TV is my babysitter screen time and it doesn't apply to homework, it doesn't apply to education and it doesn't apply to anything that's therapeutic.

So, if that is how VR is being used then I think it's appropriate and consistent with the screen time recommendations.

A question we get a lot of in the VR research space is have you ever used extended reality for kids with cognitive or developmental difficulties you know issues around children getting Novocain infections for dental procedures can have developmental delays and can VR be used with that population. And honestly to date we don't have any good, randomized control trials or data suggesting whether VR is or isn't good for kids with developmental disabilities, so you have to gauge chronological developmental considerations as well as trying to use some of this technology in extend it into kids who might have more difficult times in the healthcare space as

a function of their cognitive development. So, these are things we always consider and think about and again want to study in a rigorous way and a controlled way and make adjustments as we need to as we go along so again a really important topic to consider.

>> Perfect. Well thank you. We hope that this was a helpful overview for you all. Thank you so much for having us today.

>> Thank you very much.

DR. LYLES: Hello. Thank you so much for having me today. I'm going to spend a few minutes talking about health equity especially use VR for chronic pain management.

So, I thought I would first start just by describing what I mean when I say health equity and where we're at with using virtual reality to address disparities in chronic pain, and then end with just a few recommendations from our recent work in this space.

So, I like this visual from the Robert Wood Johnson Foundation to describe health security as the opportunity to everyone to live the healthiest life possible. And specifically, this lower panel showing equity, and its ability to tailor and personalize interventions to meet people where they are and to address structure – barriers and the struggle barriers that individuals face in achieving their healthiest life possible.

And the reason I show this when we're thinking about digital health and VR is that I think technology offers us the best chance of achieving this bottom panel by really tailoring technology, by digital skill level or language or culture, background, so that people can really have interventions like VR that are personalized and most meaningful for them.

That being said, we of course live in the United States where we don't have health equity currently. Specifically for chronic pain management, which is where we've been focusing, there are a lot of disparities in chronic pain management by race, ethnicity, by insurance status and

income within the United States, for individuals having higher pain severity, receipt of pain medication, delayed access to care and treatment. And so, you can see here some examples of that, of where we're starting when we think about the chronic pain management space.

And VR, of course from my vantage point, offers a lot of potential to reduce some of these disparities in chronic pain management to offer that tailored and personalized view that I just showed and so we set out to try to understand what kind of scientific literature that was out there focused on VR to reduce disparities in chronic pain. And what I would say the biggest finding from this sort of review of the literature was that only a few studies have really looked at this, at this topic, so we could only find five studies that assessed the usability and virtual reality for chronic pain among a specifically historically marginalized patient population. And so, there's a lot of room for growth in this space and there's a lot of room for more equity focused studies in this domain.

That being said among the small handful of studies that we did find, most of the studies found a high usability and high interest among diverse patient populations in using VR to manage their pain. And specifically, we were interested in sort of thinking about the healthcare context so none of the studies were conducted within safety net healthcare settings which I'll touch on again in a minute.

Okay, so that's how we're thinking about equity and where we're at in chronic pain and using VR to reduce disparities in chronic pain but overall, I wanted to leave you all with this world of digital health equity and if we all wanted to use VR to really reduce some of the disparities and inequities that we see. I just wanted to make the case that we've been thinking a lot about how we have to be doing this across sectors to really make a dent in equity so this is just a visual representation of this multi sectorial and multi-factorial work but the point being

that is that if we want to use VR for chronic pain management as one example, we have to be thinking of the policy landscape like how broadband and how devices and headsets are accessible to individuals across the United States. We have to think about the service domain – how people receive healthcare and how they interact with their service providers. We of course have to think about the community in which individuals live and trusted partners within the community, how people live, their family and home environment and how that influences how they use technology like VR and of course centering on the individual, their skills, their interests, and their readiness to use different digital tools. And so, I showed this just to say all of our work hopefully can be moving us out of one level of influence within this and hopefully thinking more broadly about digital health equity, and I think VR is a great example of how we can move beyond and think across levels here.

That's sort of the background, that's sort of where we're starting from. We just completed one study that we just submitted for publication, trying to work on this digital health equity space within VR. And so, what we did was we recruited patients from the public healthcare delivery system in San Francisco where I work, the San Francisco Health Network. So, these are patients who are primarily covered on Medicaid or are uninsured patient populations within our city of San Francisco. And we recruited them to really try out a VR headset and to test how it would work for them to manage their chronic pain. And we interviewed them, we recorded the interviews and we watched them using VR headsets and overall when we engaged this type of end user and this patient population, many of them who had never use a VR headset before ever in their life, the usability was high so similar to that previous study, the studies that I showed overall our patients were able to complete tasks within the VR headset, they completed the VR tasks for pain distraction, they completed the

empowered breath sequences and the mindfulness sequences within the VR headset and so overall I would say there was high interest and high usability of the platform.

But when we talked to them about using the VR system and sort of how they might use this outside of our study and outside of the interview that we completed with them of course they couldn't separate using the VR headset from their existing care management process. So, they had a lot of questions about how they would use VR in combination with their medications or with their physical therapy or other systems that they were already using to treat their chronic pain. They had a lot of questions about how this would supplement their care with their healthcare providers and their healthcare team, that they've already been working on with their chronic pain management. We really emphasized how this VR platform was going to have to complement their ongoing processes moving forward so I think this study offers just a really small insight into how we had a lot of -- we watched a lot of people use the technology and have a high interest in it but it automatically moved us up into some other domains of how VR was going to address their health and everyday lives so how they are going to use it at home and how they were going use it in the service domain with their healthcare provider and so hopefully a study like this can give some ideas on how we center different communities and how we design and test VR platforms to make sure that we're both designing the technology as well as the implementation process to meet the needs and preferences of real world end users.

And so if I had to summarize sort of this overall landscape of digital health equity and our study on using VR to address chronic pain management within a safety net healthcare system, I would say we all can be thinking differently about the design of our digital health platforms to be based on communities and preferences so we engaged stakeholders in the testing process, with the same process of engaging community and codesign with patients and with

communities directly, I think can change the types of products that we're putting out, putting out for payments and communities to leaders and also improve them for everybody to have them more accessible, more streamlined and just more relevant overall.

The second point I wanted to leave you all with is that I think there are some basic recommendations that we can move forward from this work and from other work on our team that we can design things for different users based on varying ranges of digital skills, varying literacy levels, by using audio visual features and then various languages to try to widen the acceptability of the platforms at the start and really thinking about that as principles that we use in all of our digital health work moving forward including in the VR space.

And then lastly, I showed that multi sectorial figure and I can't stress strongly enough that I think to do this equity work we're going to partner in new and different ways and collaborate not only with the community and listening to the community in when their interesting and need is, but also with private sector, with policy makers and beyond. And so, if you really want to achieve digital health equity, I hope these examples of how we can partner and collaborate in new ways will also allow us to think differently about the problems that we have and the solutions that we can create to overcome them. Thank you so much for your time.

MR RAZZAQUE: This is a short talk about vision therapy, my experiences, and also hopes and concerns as a patient.

Before we start, a couple of quick disclaimers. I am an engineer in the AR and VR and medical device fields. These opinions though are my only personal perspective as a patient. I'm not speaking for any of my current or previous employers, and I'm also not promoting any specific product or service.

I suffer from double vision, particularly when tired, for example, after a long day driving

home in the dark, I would see two traffic lights instead of one. While I was in undergrad it also made it difficult to use stereo microscopes, and even being in class lectures, it was difficult to switch between focusing on the white board or chalkboard, and the notes that I was writing. I was diagnosed when I was about 20 years old and then I was told, at that point I was told there was no treatment for it. But then 20 years later when this came up with another eye doctor, he suggested vision therapy. For each image that I used, none of these are my own images so I report the source below, beneath the image.

So, my experience with vision therapy consisted mostly of exercises with paper and physical prompts. These are two examples here of things that I used in particular. Again, I'm citing the source, not promoting any specific product.

These exercises required crossing my eyes and trying to fuse these multiple images into a single 3-D image. I also had exercises with string and balls on the string. And then in the office, one of the offices where I was treated, they also had VR devices and VR-like devices. So, these are two examples of things that are similar to what I used. Again, I'm not promoting these. These are just the sources for where I found the images.

One of them in the upper right was a large 3-D TV that could track my eyes, so I was instructed to look at various targets as they were moving throughout my field of vision. The nice thing about it, it was very engaging, much like a video game. Had instant scoring which also helped with the improvement, and I could see improve session to session and also adaptive. It was easy to make sure I was at the right level of difficulty to be both challenging but not too challenging.

The therapy that took place in the office, it was you know very effective. It was supervised. Somebody could watch me and correct me if I was doing something wrong or I

needed to try something different. I also had a couple of downsides. We all know the pain of having to take appointments and then take time off from work and travel to the office. For my vision therapy the additional disadvantage of being in the office was that the exercises, both the paper and physical ones and the electronic ones were extremely fatiguing. I would often not feel safe having to drive back to work or to home afterwards. A couple times I actually took a nap in my car immediately after leaving the office. It was also expensive. I think by the end I was paying -- not covered by insurance, so paying over a hundred dollars a session.

And then often the VR vision therapy system was not working. The physician mentioned that there was you know weekly Windows updates and then graphics card, driver updates, and then VR system updates, and then finally the app itself needed updates. And any one of these could cause it to not work and required a visit from the company that supported it. So often when I went to the office it wasn't available.

On the other hand, the at-home exercises were -- required a lot of effort and dedication without somebody sort of watching and coaching me. I'll have to admit that my own compliance wasn't as good as it should have been, and I probably would have had sooner or better results if I was a more compliant patient.

So, if I had to do it again, I would like to take advantage of the now available at home therapies with VR. You know I would have the daily automatic scoring and sharing that data with the therapist that I would get -- you know that normally requires an in-office visit. I would have the opportunity to do these exercises before bed and not having to drive home after or go to work afterwards.

I'm excited that it could possibly be on an affordable device that I already own for my own entertainment. And I'm excited about not just the potential for vision therapy but also

physical therapy and mental health therapy as well. There are some really exciting diagnostic applications when you add eye tracking to the VR headsets.

I'm also very encouraged that there are new entrants to the field of development. So instead of traditional medical device developers, or in addition to traditional medical device developers who are also getting talent from game development and from fitness apps.

So, while I'm very excited about the potential for at-home VR therapy, I also have a concern, and my biggest concern is that of what happens to my data? You know, there can be intentional sharing of data that is undisclosed to me to both data brokers and advertisers, and I imagine this is done to increase the profit to the developer. But I can also imagine it's done to reduce the cost to the patient and to improve the affordability and access that way.

A lot has been published about privacy on existing mental health Smartphone apps. These are two links that I found, two stories, these are links to two stories that I found particularly relevant. And I think when we transition from Smartphone apps to apps in VR and AR headsets, the potential for danger to the patient is even greater. You know we -- by having eye tracking, the apps can see how our eyes respond to various visual stimuli and these devices can track the motion of our hands -- or they do track the motion of our hands and heads and that can also betray additional information about the patient.

In addition to the data that is being shared or sold by the developers, or intentionally being sold by the developers, there may also be sharing that is happening without the developers themselves being aware of it. So, for say an arbitrary medical VR app it will of course be running on some VR headset which has its own hardware and operating system. And the VR app also, no app today stands alone. They all use various library and toolkits, and the data if there's any cloud services will be going through you know the wireless provider or the

internet service provider. And then the cloud services themselves, if any of the apps -- any of the computation or storage or sharing is done with the back-end cloud service, all of these layers have the potential to be collecting, sharing, selling, aggregating our data. And as a patient, how am I to know you know if the developer themselves is not aware of this, as a patient what hope do I have to being able to understand what is being shared and how might -- what are the implications for my own privacy or safety?

Moving on to potential mitigations. To be clear, I'm not a privacy nor a regulatory expert. But I am encouraged that the FDA guidance on cybersecurity is having a positive impact and I think it increases awareness not only of developers and manufactures but also clinicians. And I wonder, could the FDA do the same thing or something similar for privacy? I'm all encouraged by the bill recently introduced for protecting health and location data. So that's my experience as a patient, and also my concerns. Thank you.

MR. CONWAY: I would like to go ahead and thank again the FDA, Mr. Sackman, Drs. Greenleaf, Silva, Gold, Espinoza, and Lyles and Mr. Razzaque for their presentations. At this time, we have a few minutes for a brief open committee discussion. And really the purpose of this is to ask any clarifying committees, any clarifying questions from the committee. And as a reminder although this portion is open to public observers, public attendees may not participate except at the specific request of the committee chair. Additionally, we request that all persons who are asked to speak identify themselves each time. This helps the transcriptionist identify the speakers.

And to my committee members, what I would say is we are on a timeline here. At 12:20 I do plan to start laying out the logistics for those who are participating in the virtual breakout sessions who have taken the time to register in advance. Does anyone have a quick clarifying

question? Please raise your hand. I'll go ahead and chart with Susie Schrandt, and then Bennet I think you'll have it.

MS. SCHRANDT: Thank you so much to everybody and I'll try to make this super quick. My question is very specific to the uses of VR in clinical training. And I assume or imagine that there is part of the regulatory process that's focused on ensuring that whatever the thing is that the VR is attempting to approximate is as close to reality as possible. So, if it's a ruptured appendix and you're training someone in surgical tools or surgical process it looks as feels as much like a ruptured appendix in the human body as possible.

My concern is when it is instruction for a conscious patient, whether that's training and interpersonal skills, training on a physical exam, what is the process or is there a process that ensures real patients with whatever the interests is, have weighed in, have said yes, this is a close approximation of what the lived experience of a patient with this condition is like or yes, that approximates the emotional response or the behavior. I'm just curious if that exists and if it doesn't it certainly needs to. So that's my question.

MR. CONWAY: So, who would like to go ahead and take a shot at answering that from the prior presenters?

DR. GREENLEAF: : I would be happy to jump in.

MR. CONWAY: Thank you.

DR. GREENLEAF: : I think it's clearly good design, requires that sort of input and good product development. All aspects of getting it right and most if not all of the groups I meet both in the academic arena, and in the commercial arena who are developing virtual patient similarities are spending a lot of time trying to get it right, to understand the patient's journey, and to design for diversity of all aspects of diversity and inclusiveness.

Now, is it something that people could do better? Yes. But is it something people are building into their design? Absolutely.

MR. CONWAY: Thank you very much, Dr. Greenleaf. And Bennet, let me go to you for the last question for this portion.

MR. DUNLAP: Thanks. I'll try to be quick. This is a question for our friends at FDA that spoke earlier today about frugal processes. And I would just love if they could give us a little bit of clarity on how the privacy of data that was just brought up is considered in the evaluations of a medical device, if it is, and how the communication of that and the patient could happen. Thanks.

MR. CONWAY: Thanks. Somebody from FDA?

DR. RASHID: Yes. Thank you so much for that question, and really such an important and timely question indeed. I think I would like our colleague here, Angie Krueger, who is with us at our office of policy is our lead here to perhaps weigh in on that.

MS. KRUEGER: Hi, this is Angela Krueger. I agree that privacy is very important, and we do consider that in our review. The previous speaker addressed cybersecurity and we take that very seriously along with privacy considerations so that is something that we consider in the regulatory framework. We would have to consider what our regulations allow in any specific context, and it may be different for a clinical study versus a premarket review versus post market data collection but that is something we would consider appropriately in the context of our review in in I particular situation depending on the context.

MR. CONWAY: Great. Thank you very much. Thank you, Bennet, and thank you, Angela and thank you, Leeda. At this time, it's about 12:22 and during this time those who are confirmed participants for the virtual breakout sessions will need to log out of the webcast and

log into the Zoom link they were provided so the virtual breakout session can begin promptly at 12:30 PM.

During the Virtual Breakout session, I invite those confirmed participants of the Virtual Breakout Session to participate in discussions that are focused on the scenario questions that were previously provided to them, as well as included with the Background Materials posted on FDA's website for this meeting.

FDA moderators will provide breakout participants with additional instructions for the Breakout Session once they are logged into their virtual breakout rooms.

As a reminder, this part of the meeting will not be Webcast and the Committee members will not be present or participating.

The Committee members, those audience members that are viewing via webcast who are not participating in the virtual breakout session, and those who participated in the virtual breakout session, will rejoin the webcast at 1:25 P.M when the meeting reconvenes at the conclusion of lunch.

Committee members should return to the Zoom platform, and those that are viewing the webcast will need to rejoin the webcast at 11:20 -- my apologies, at 1:25 P.M. to continue viewing the rest of the meeting.

The meeting will officially reconvene at 1:30 P.M. Committee members please do not discuss the meeting topic during the break, amongst yourselves or with any member of the virtual audience.

Again, the meeting will resume to the general public at exactly 1:30 P.M but we ask that you join on the platform at 1:25 P.M. Virtual Breakout participants please be aware that it will take the entire 5 minutes to get everyone situated into their rooms.

Also, when you join the Zoom platform you may be placed in a waiting room until you are placed in your virtual breakout room, so we ask for your patience. Please begin logging into the Zoom Platform now and I'll ask the FDA A/V staff to ease proceed with closing the webcast. Thank you.

[Breakout sessions]

[Lunch break]

MR. CONWAY: It's now 1:30 p.m. and the committee has returned, and I would like to go ahead and resume the committee meeting. We will now begin our virtual breakout summations. The summations will reflect the major themes that were discussed in the breakout rooms in response to the scenario questions. The summations will not be transcripts of the discussion but instead highlights from the discussion.

If there are additional points that were not covered by prior moderators, subsequent moderators can feel free to add comments when called upon to report out.

At this time, I would like to go ahead and ask the moderator for Breakout room 1 to summarize your room's discussion.

DR. BOCELL: Thank you, Paul. My name's Fraser Bocell. So, the first thing that came up was discussion of -- oh, and the question is what would you expect a healthcare provider to communicate to you about the device? And the first thing that came up was does the healthcare provider have any conflicts of interest? Are they involved with the device or the company or anything like that and then get into more general things about how long it's been on the market, is it regulated by the FDA, has it gone through conformity assessments so basically is it safe and effective?

And then they would also want to know what the patient experience is like with this device. Like would the general experience of being with virtual reality, if there's emotional for motion sickness or psychological effects, things like that, and kind of what the accompanying research on that is. And then also do safety checks. So are there any problems with comorbidities, what's the intended use of device, what type of populations should use this device, is there anything that should bar a patient from being able to use the device. Thank you.

MR. CONWAY: Thank you very much. I appreciate it. At this time, I would like to ask the moderator from breakout room number two to summarize your room's discussions.

DR. HARNER: Thank you, Paul. This is Chris Harner, moderator two. The question we had, and this is for the child and parent seeing a physician, so the question we have is do you think your healthcare provider should be the main point of contact to educate you about the device? Yes, but also other parents and family should be a point of contact. Most people would probably get their primary information not from the clinician, but they would get it from the internet or other sources such as Facebook, of which the moderator then asked is this good? To which the group member replied it is not good or bad. It is just the way the world currently operates. The way people inform themselves would depend on if the treatment was administered directly to the consumer or if it is prescription based. And finally other sources of information could be from the manufacturer and/or other patient groups. Thank you.

MR. CONWAY: Thank you very much, Chris. Now I would like to ask the moderator from room number three to go ahead and summarize your discussion.

DR. SACHS: Yeah. This is Bart Sachs for moderator three, and I really have to thank -- I had a great note taker and I had wonderful people in my room. So, the question that we're

answering and addressing is, would you expect or want to receive training and information about the device from anyone else besides your healthcare provider? The feedback that we have was that it depends on the device, first of all, if the device was for use by an occupational or physical therapist then please include them. They should act as part of the trainers if the device is truly conducted and managed by the physician then the physician should be familiar with doing and using the device themselves and she or he should give the feedback, that it would be nice if there was a cohort of other parents who are in the same situation and working within a group as a support type group during the usage of the device that the parents could interact with each other and information could be traded. Another point that was brought up was that our -- people in our room felt that they would like to receive information from the sales, customer or technical outreach people from the manufacturing device and have somebody available to answer those questions and revisit materials and training visit -- or training videos that would be supplied by the manufacturer themselves. And then we also had one person that brought up that they would like a peer-to-peer training, making sure that the peers are actually trained and have sound advice within guardrails that independent consumer groups and patient foundations are focused on the patient education.

Another route of neutral information, they would like some neutral information rather than just from the providers and weren't the manufacturers. And last point, in summary then, we felt that the information should be shared among the work groups, technical information was important, and peer to peer consumer groups were important. Thank you.

MR. CONWAY: Great. Thank you very much, Bart. And before we move on to the moderator from room number four if I can just encourage all the moderators as you're listening closely to the questions and the summations here, if you have contributions to make that you

might have picked up in your breakout sessions, feel free to go ahead and make those. Go ahead for the moderator now for breakout room number four, if you could go ahead and summarize your suggestions.

MS. WEINBERG: Sure. I'm the moderator for group number four. My name is Jessica Weinberg. And actually, I have a contribution to question three. One of our group members noted that in addition to non-profits or other organizations vetting videos that sometimes manufacturers could work with the patients to produce videos and instructions the patients would then trust. And then also they raised the issue of safety in terms of someone producing a video in terms of how to hack into a device, that wouldn't be a safe video. Whereas if an individual or patient worked with a manufacturer then the manufacturer could ensure that safety and correct adherence how to use the device was being shown.

So now for question four, how do you weigh the risk and benefit trade-off in device deciding whether your daughter would use the device. If participants said they would trust the psychiatrist and making sure they were aware of other issues the child had and could help you navigate this decision. They said it's important that the provider in question make sure they know the daughter's history, their specific needs and pain points and sizing since that may change. They said that as a patient or as a patient their ability to parse through all the information about the device is limited so they would want to trust that the doctor's educated and that they would vet the device for them. They want to know the overall therapeutic plan, if this is an ad junk to an overall journey, how do we get there.

They also expressed concerns about the durable piece of equipment and cost. They said if I buy this, how do I know that the patient will like it or what if they hate the device and then how long will this device last? Their concern about costs and accessibility, kids grow up so fast

that they may need another device because of the size, and that definitely impacts the cost. And if their daughter hates it, they're out the cost of the device, whether that's $500 or $5,000. And they also noted this depends on the population. At a federally qualified house center, cost really matters if when doing a cost benefit analysis, they would also want to think about the side effects. With AR and VR, the side effects may be filed compared to some of the groups used for autism. They also raised the question of whether the combination of drugs and the device is problematic if a drug causes dizziness would the device exacerbate this? And if the drug causes you to be more muted in your response to stimuli, will it impact the efficacy of the device. That's all I have for four.

MR. CONWAY: Thank you very much, Jessica. Before I move on, do any of the other moderators have any comments on the questions that were posed earlier? Bart, go right ahead.

DR. SACHS: Yes. In addition, the people in my, in our group were concerned when they talk about risk they brought into the risk of release of information and protection of the information more like HIPAA situation because they wanted to know who the information during the use of this device would be released to. They were afraid that once it gets out there, it's available to anybody and there's no way to protect it. So, they brought that point up. And they also brought up the idea of having an app that they could interact with if it would be available from a manufacturer or from the provider.

MR. CONWAY: Thank you very much, Bart. And Anil, I see your hand raised also.

MR. KOCHHAR: Hi, thank you. This is Anil Kochhar, moderator for room six. I have a couple points about question number one. What would you expect your healthcare provider to communicate with you, they mentioned they would like to understand what kind of

information he has about patients, about their child's specific age and then real quick regarding question number four about benefit risk trade-off, our attendees also indicated that they would evaluate the benefit and risk compared to what child was doing before so basically you know they were having trouble taking medicine, et cetera, so thank you.

MR. CONWAY: You bet. Thank you very much. And now what I would like to do is go ahead and ask the moderator from breakout room number five to summarize your discussions and as you listen to the other moderators if you have any other comments at the end of that please feel free to add them. Go ahead.

DR. ZHANG: Thank you, Paul. This is Caiyan I'm the moderator for virtual breakout room number five. The questions that we got is what additional information can help you make a decision about a need to use a device to supplement medication use. So besides the common themes that you have heard from the discussions from the other rooms, the additional things I'm going to add on from the -- our group is that the participants in my room, they would like to know some literature about this particular device or the therapy from the health provider and also they would also want to know when should they stop the treatment if any issue arises. They might have some questions as far as around the insurance coverage for the new device in the treatment as well. And additionally, depending on how long the child will be using this particular device, some of them also raised the question about worrying potential addiction issues. Say for example if the AR/VR device includes some sort of video games in the treatment, and which might result in like the child wanting to spend a lot of time using the particular device. That's it from my room. Thank you.

MR. CONWAY: Thank you, Caiyan. Any other comments on that and then Anil, thank you very much, and Jessica. Why don't we go ahead and start with Anil then we'll turn to you.

MR. KOCCHAR: Sure, thank you. This is Anil moderator for room number six. In our group had mentioned they would want to understand more about the maintenance issue of the device so for example, a child with autism they already have a full schedule of videos it's and if we're adding on another – to make additional visits to maintain or calibrate the device that may be something they would have to consider as well given their other full schedule of appointments, et cetera. Thank you.

MR. CONWAY: You okay. Thank you very much, Anil. And Jessica?

MS. WEINBERG: All right, yep. Our participants said they would like to know as well about if there is a need for updates for software in the future what that schedule would look like, if there's coverage for updates to the hardware and the software and what frequency that would be at, so for example a wheelchair can only be covered every five years for a new wheelchair and children will outgrow them in that time. And they also wanted to know what's the impact of stopping the therapy if they decide will there be a need to stop midway through will there be any negative effects.

MR. CONWAY: Okay. Thank you very much, Jessica. Any of the other moderators have any other contributions that you would want to make on these preceding questions? Okay. Thank you. Now I'll go ahead and ask for the moderator from breakout room number six to summarize your room discussions.

MR. KOCHHAR: Yes, hi, this Anil Kochhar moderator six our question is since you can't see what your child is watching what would you like to feel confident that the device is doing what they're supposed to do? so in our group they mentioned they would like the have the manufacture calibration set up to include a pretest to make sure the child is actually following the directions so that if the child isn't following the directions then the machine wouldn't move

to the next step. They would also like to see some sort of indicator externally that shows if the patient passed the safety check point and is able to start, for example a light to indicate that. And then lastly, they mentioned a safety switch or something to see if the patient or child is going over a certain threshold for example experiencing some sort of distress, that would indicate that the device needs to step back and take a break. So, they mentioned this could be captured through maybe monitoring blood pressure, heart rate, et cetera. Then lastly, they just mentioned education is key. So, thank you.

MR. CONWAY: Great. Thank you very much, Anil. For the other moderators, Chris, go right ahead, thank you. Let's actually go ahead and do is this. Chris Fraser and Caiyan, I don't know if you'll go ahead and wrap it up but let's start with Chris and then go to --

DR. HARNER: Chris Harner, moderator two. Our room was particularly interested in what the child was experiencing, making sure that we got information from the child through discussions with the parents and the clinicians so the other question probably even more important is what role does the child play in all of this, in using the device, so there's the comment about focus groups that should include the kids, the child is upset in classes can the physician intervene to help the child and the long term damage. Thank you.

MR. CONWAY: Thank you very much. That was Chris Harner, FDA. I'll ask each person to please identify your full name for the transcriptionist. Let's go ahead and move to Fraser at this point. You're muted, Fraser.

DR. BOCELL: Fraser Bocell with the FDA. One thing that was mentioned in my group is that the headsets have lots and lots of sensors and all types of data that they can provide, and they mentioned about that can be conveyed to the healthcare provider to give more data on what the child's experiencing and what's going on with them.

MR. CONWAY: Okay. Thank you very much. Caiyan?

DR. ZHANG: Hi, this is Caiyan Zhang from room five. I have a similar but not exact same response from our group for question six, the participants would likely -- would like to have access to some sort of application or website where they can go to so that they can experience what their child is going through similarly and knowing how the journey is for the treatment. Thank you.

MR. CONWAY: Thank you, Caiyan. Bart and then Jessica.

DR. SACHS: Yes, this is Bart Sachs. I'm also from moderator from room three and from the FDA. In addition to what's been stated, two of the participants in our group talked about having a user-parent dashboard that they could refer to that would help them monitor the device, and also to know if the parent, as they were saying, is not tech savvy, what type of malfunction they might be concerned about and recognizing that and addressing it and fixing it before they wait for another 2-week visit when they're actually seeing a provider or physician or somebody like that, they want to get it fixed right away.

MR. CONWAY: Great. Thank you very much, Bart. And that was Bart Sachs, FDA. Jessica, go right ahead.

MS. WEINBERG: : I'm Jessica Weinberg, moderator four from FDA. In addition to what's already been said, a couple of you our participants said they would like the option to watch when their daughter is watching – while their daughter is watching it. They said that that's an option they've seen in some technology. They also said that there should be a storyboard that walks the patient through scenarios so they would like to see the scenarios that the daughter – via a storyboard if that's available. And I also wanted to add to question five, one thing I forgot, they wanted to know what the doctor's experience is with the device, if they've actually had a

patient use it before and what that experience was like, or if they're recommending this blindly.

MR. CONWAY: Okay. Thank you very much, Jessica. Let me go ahead and move to the moderator for breakout room number seven and ask that they summarize the discussions, and then I'll ask for another round of FDA moderators to listen closely to the answer to this and contribute anything from your groups so if we can go ahead with the moderator from breakout room number seven. Thank you.

DR. CHEN: Good afternoon, this is Allen Chen, moderator for breakout room seven. Our group is reporting n questions seven and eight. I'll start out with question seven. Question seven was talking about assuming there's a 15-minute prescribed time for use of the device and asking if it's simply -- if it's simply informing you and your daughter of the 15-minute prescribed time is sufficient or if some type of other control, such as an auto shutoff after 15 minutes would be better. So, our team, our group definitely recognized that we don't want to (indiscernible) child on exposure therapy for example for one hour in a public setting. And so, it is important to have some type of control other than just simple informing of the parent and the daughter.

So, I think that the -- in general the group had different thoughts based on whether the prescribed time was for all patients, if that were the case then a 15-minute auto shutoff should be the way to go. If the prescribed time will vary based on the patient, then there are some considerations. So as a parent, the parent would want the ability to shut off the device after 15 minutes if that is the custom time allotted or prescribed for their daughter. And if the physician has a specific prescription plan. For example, trying the device for ten minutes at a time for two weeks and then changing that to 15 minutes at a time for the next two weeks, then our group would want to allow the physician to have that ability to change the -- that time on the

device.

And then the team also acknowledged that there could be a situation where this device programmed to allow for the patient, the daughter to advance to the next level if they're performing well at that first level one of 15 minutes. And so, if that is the case and if it has been tested to function well in that regard, then a control there would be to program the device to advance upon successful completion of level one. But one important consideration from the team was that no matter how they present the prescribed time is controlled it will be important that after that time, for example the 15 minutes is up, that the participant shouldn't just get a black screen. There should be some signal that they have completed their prescribed time and that will help also reinforce the experience. So that was some of the things from our group for question number seven.

I'll now move on to question number eight which is focused on concerns about if the child's perception of reality as a result of routine use of the AR/VR technology, and possible concerns about overuse and underuse.

For this question we heard mixed thoughts and at the same time acknowledging that there could be not as much concern due to children these days already being exposed to cartoons, exposed to other ways that their imagination is being utilized as well as exposure to iPad as they develop. And so, it might not be that much of a concern, however the concern still exists that we do want to ensure that the child's perception of reality is healthy. And so, with this regard the main two concerns would be bias as well as confusion between what they see in their virtual reality and in reality, their daily life. And so, some of the group's thoughts regarding these topics were that they would hope to have multiple conversations with the child psychiatrist to discuss and plan, to ensure that the child's perception of reality is not indeed

impacted. The parent would want to see and know the content and the environment or the setting of that content so that they can understand what biases may be presented to their daughter in that situation. The group also acknowledged it would be important as a parent to be able to monitor the progress before and after the treatment.

And in terms of the concern about the child being confused about what is reality and what they saw in the VR, one way that the group mentioned that could be a signal of this is if the child were to ask the parent document that time we went to the park and if that park is actually an experience from the AR/VR experience then that could be a signal of concern.

In terms of the overuse part of this question, the -- our room generally thought this might be dependent on the child so if the child is usually sucked into technology and go hours on end to use technology then it may be important to work with the psychiatrist to set a framework for when to use and how to minimize that potential dependency on the technology. So those are some of the thoughts from our room. Thank you and I'll turn it back to you, Paul

MR. CONWAY: Great. Thank you very much, Allen. I appreciate it. So, in listening to the summation of breakout room seven and the answers to seven and eight I'll go ahead and pose this to the other moderators. Any comments from your room that would relate to that? And we'd go ahead and start with Jessica. Go right ahead, Jessica.

MS. WEINBERG: : Thank you. Jessica Weinberg, moderator four. One of our participants mentioned for question seven that some of these devices may have a dose response curve so what that means is that the patient might get even better response with more time, so they're not -- they wouldn't necessarily be worried about only doing 15 minute -- or about doing more than 15 minutes because the patient could get more benefit. However, they said that is assuming standard parental controls where they could cut the daughter off if she was on for

too long.

For question 8 one of the participants said that they were concerns about children looking at screens close up, wondering if that would be a problem later in life for their vision or other functions. And also, this person wondered if there could be things added to monitor for any long-term side effects such as vision issues

MR. CONWAY: Terrific. Thank you very much. And Anil, go ahead and bring it home for us, your comments.

MR. KOCHHAR: : Yes, yes. Thank you. Anil Kochhar, moderator from room six, so two comments on number eight about the concerns you may have about your child's perception of reality. So, one is this doesn't raise additional concerns beyond computer games and other programs already out there. Then we had a second comment that said they would be a little concerned if the kid or child starts to see the medical device as a game, especially if there isn't -- if there aren't hard wire cutoffs. Thank you.

MR. CONWAY: Okay. Thank you very much. And then Bart. Thank you.

DR. SACHS: Yes. This is Bart Sachs, also from the FDA, moderator for room three. And this is a comment in general that in listening to each of the other moderators present their information from their room, I'm taken by and amazed by the fact that we had different rooms, different participants and these individuals are really bringing up very similar points that I'm hearing from each of the rooms that I would -- at least I was hearing in my room and other people have shared, so it's -- these are more universal themes that I think we're hearing and we're sharing.

MR. CONWAY: Thank you very much for your observation, Bart. I agree with you. I would like to thank everyone for their participation in the virtual breakout sessions. This

concludes the virtual breakout summation portion of the meeting.

However, I ask that the FDA moderators remain available for our discussions after the open public hearing. Open committee discussion just in case the committee has clarifying questions for you. And again, I thank the hardworking professionals at FDA for working closely with the committee and with us today.

We will now proceed with the Open Public Hearing portion of the meeting. Public attendees are given an opportunity to address the Committee and present data, information, or views relevant to the meeting agenda. Ms. Williams will read the Open Public Hearing disclosure process statement. Go right ahead, Ms. Williams.

MS. WILLIAMS: Both the Food and Drug Administration, FDA and the public believe in a transparent process for information gathering and decision making. To ensure such transparency at the open public hearing session of the advisory committee meeting, FDA believes that it's important to understand the context of the individual's presentation. For this reason, FDA encourages you, the open public hearing speaker, at the beginning of your written or oral statement to advise the committee of any financial relationships that you may have with any company or group that may be affected by the topic of this meeting.

For example, this financial information may include a company's or a group's payment of your travel, lodging, or other expenses in connection with your attendance at the meeting.

Likewise, FDA encourages you at the beginning of your statement to advise the committee if you do not have any such financial relationships. If you choose not to address this issue of financial relationships at the beginning of your statement, it will not preclude you from speaking. Thank you.

MR. CONWAY: Great. Thank you very much, Ms. Williams. The FDA has received nine

formal requests to address this committee. Speakers who submitted their request to speak by the deadline indicated in the meeting's Federal Register Notice will be given 5 minutes to speak. We'll now go ahead and begin the open public hearing with a presentation from Dr. Joe Morgan, president of WAYA Health. Dr. Morgan?

MS. WILLIAMS: Paul, before we do, I want to clarify. We received eight requests.

MR. CONWAY: My apologies. Okay. Eight formal requests. So again, we'll go ahead and begin the open public hearing with a presentation from Dr. Joe Morgan, president of WAYA Health. And Dr. Morgan, go right ahead.

DR. MORGAN: Hello everyone. My name is Joe Morgan. I'm a practicing anesthesiologist and my disclosure is I am founder of Wellevate LLC. We've been in business for six years and have been developing virtual and augmented reality solutions for over five years now.

So how does augmented virtual reality address the needs of patients? I think it achieves this through several different mechanisms, the most telling of which are number one that it achieves very high levels of patient engagement, whether that's wanting an individual to just focus on the assessment before them or whether you want to achieve complete distraction. Virtual and augmented reality is capable of delivering very efficacious and ecological education through immersive learning, and the technology also enables remote care that really surpasses the current paradigm of telehealth in terms of capability and convenience for patients. And it's broadly capable of addressing the various different bio psychosocial aspects of disease.

In terms of safety considerations, I won't read through the whole list, but I think the most important point to make here is that, you know, safety concerns and considerations are really handled in large part by involvement of clinical subject domain experts throughout all aspects in creating the solution from ideation to design, development, deployment and evaluation.

I think it's safe to say that virtual and augmented reality has been shown to be efficacious in a variety of different realms within healthcare and you know in the context of a variety of different diseases and the point I want to make here is that it's really important to keep the patient at the center of all of this and you know patient reported outcomes are very important.

In terms of patient perspectives, I think that you know having efficacy determinations being made by patient-reported outcomes is important to them as well. Also, that you know patients want more convenient options for their care. And as I mentioned before this is a great enabler, in terms of the provider decision making, I think first and foremost right now we are in an interesting time in that I think there's a substantial amount of evidence out there for this technology in healthcare and really awareness amongst providers is critical. And provider decision making to use this technology really revolves around robust data to support clinical use, having things that are more convenient for patients, and really having the technology that has really been shown to achieve engagement for individuals and yield objective results.

So, some factors to consider in evaluation. Were clinical domain experts involved in all steps of the design, development, and process? I think that's a critical item. And then you know when looking at the novel attributes in technology and what challenges they bring, just two items I want to touch upon briefly. Number one, obviously the 3-D experience content itself is critical, and this -- the challenges that come from that are you know if this -- if you get this wrong then that can actually not only lead to lack of efficacy, but it can also open the door to safety concerns.

And then which flavor of augment order virtual reality you want to use really ultimately relates to the use case itself. And so, you know considerations for vulnerable populations, the one point I want to make here is that embedding accessibility features into software really goes

a long way in enabling these vulnerable populations to participate in this technology.

And so, in closing, our recommendations are really for the FDA to continue their current programs for which this technology can be entered into, and that it's absolutely critical that clinical domain experts are involved at all steps of the process when making those solutions. And so, I want to thank everyone for your time and the opportunity. I look forward to the Q&A. Thank you.

MS. SCARATO: When you use a cellphone or a wireless device near your head, some of the wireless radio frequency radiation is absorbed into your brain, your eyes. This is a 2018 study published in environmental research which was the first to model cellphone radiation in a virtual reality position in a child model. The study found that compared to adult models' children experience two-to-three-fold higher radio frequency radiation doses to their eyes and frontal lobe when the cellphone is used in the virtual reality position.

The colors you see represent the rate of radio frequency radio absorption into tissue with the most intense levels being yellow and orange. Our organization was the lead petition on a case against the SEC regarding radio frequency radiation exposure limited and in August 2021 the U.S. Court of Appeals for the D.C. Circuit ruled in our favor, finding that the FCC had ignored scientific evidence and failed to provide a reasonable explanation for its determination that the FCC's 1996 now two decades old regulations were still adequately protective of human health. The Court ordered the FCC to provide a recent determination and specifically to address the evidence on impacts to children and long-term exposures. Now the Court specifically noted that the FCC ignored the American Academy of Pediatrics repeated letters which stated that children are more vulnerable to wireless radiation. Scientist studies documented children's brains are more sensitive as they're still developing, plus there is deeper

penetration, more intense penetration into their brain. They have thinner skulls and smaller heads. And they'll have a lifetime of exposure.

Peer review research has demonstrated a myriad of adverse biological effects from radio frequency including brain cancer, DNA damage, oxidative stress, altered brain development, headaches, damage to reproductive organs and memory damage.

A recent published review found the majority of animal studies and cell studies had increased oxidative stress within regulatory limits and the authors note that adverse conditions such as diseases like diabetes, neurogenerative diseases compromised the body's defense mechanisms including their antioxidant protection mechanism. And individuals with preexisting conditions are more likely to experience health effects. A just published letter in the journal of the national cancer institute by U.S. experts concludes that there is a need for the public to reduce exposures to radio frequency radiation now. However, the FDA website inaccurately communicates to the public that safety is assured. The FDA has even written elected officials that they've evaluated all of the scientific evidence when in fact they have not shown any review of the totality of the science. There is a now outdated FDA literature review but it's only on cancer and cellphones. It does not review science on children's vulnerability, oxidative stress, impacts to brain and memory, and it dismisses the $30 million national toxicology program study that the FDA itself requested, a study that found DNA damage and concluded clear evidence of cancer.

Importantly, it does not meet scientific criteria to be a risk assessment nor an evaluation of FCC regulatory limits yet the FDA wrote Senator Tammy Baldwin that the agency has conducted and published a detailed literature review of all of scientific evidence that has become available over the past decade and updated our web pages related to all aspects of

radio frequency radiation from cellphones. We are opposed to the FDA taking any action that increases or allows radio frequency radiation to children's brains especially in the virtual reality position until there's a science based up-to-date transparent research review and risk assessment that's been completed by independent experts with the opportunity for public comment. There was no premarket safety testing for long term exposure. There is no ongoing U.S. government review nor post market surveillance related to wireless radio frequency radiation.

Here are some questions to ask the FDA. Where is the up-to-date research review on the totality of the science? Where is the risk analysis on impacts to a child's developing brain and eyes from radio frequency radiation?

In light of the research on oxidative stress and brain damage, what could the potential health effects be from the FDA policy allowing exposures to the brain from virtual reality in a medically vulnerable population such as pediatrics? What are the actual exposures into children's brains, bodies, and eyes from virtual reality in medical settings and who is monitoring it? Who will be monitoring side effects and how will that data be collected and analyzed, and how can the FDA transparently communicate their level of their review and uncertainty about the long-term safety of virtual reality?

Many countries are light-years ahead of the United States in protective policy. In Cyprus there's a public awareness campaign with full scale bus ads on public buses educating parents on how to reduce exposure. The Archbishop Makarios Hospital has removed wireless from the pediatric and neonatal wings. Belgium has banned the sale of cellphones designed for young children. And in France when you buy a phone, you're informed to keep it away from the head of children, away from the abdomen of teenagers and pregnant women.

MS. PEARLMAN: Thanks to the FDA and Patient Engagement Advisory Committee. My name is Kavya Pearlman. I am the founder and CEO of XR safety initiative XRSI. Today I'm here to represent XRSI's medical XR advisory council, a group dedicated to help building safety in medical XR ecosystems where I serve as a subject matter expert for AR/VR safety and chair for the medical XR privacy and safety framework development research.

Medical XR Advisory Council hosts multi-disciplinary panel of experts involving doctors, technologists, neuroscientists, technology professionals and most importantly, the patients. The council brings together these thought leaders, healthcare experts and visionaries to identify the risks and opportunities associated with immersive and emerging technologies including AR/VR.

The council started its mission in November 2019 and based on the work so far, we have established the following. When it comes to the risks and opportunities associated with AR/VR, patient privacy and safety must remain a priority. AR/VR applications have already started influencing medical diagnose, education and treatment. Basically, the way we receive healthcare is being revolutionized using these cutting-edge technologies. However, the council has established that we are up against a massive challenge. When it comes to the type of data and the amount of data these technologies allow us to collect, uses, share and store. Data is at the core of these healthcare solutions but what we are observing is collusion providers have already started shrugging the responsibilities that come along with these advancements.

I would like to draw attention to the disclosure provided in fine print by one of the major AR/VR solution providers and device manufacturers, Meta. Here you can see the fine print says the Meta quest two headset and accessories are not medical devices and are not intended to diagnose, cure, or prevent any disease. While the declaration allows Meta to not be held liable

for any medical related complications or assertions of misdiagnose, et cetera, the reality is these devices are not just being advertised for healthcare use but also being used as a bible to diagnose and treat medical conditions by non-medical technologies using vast amount of data that traditionally remain in the hands of doctors and were subject to HIPAA regulations.

The council further asserts that data related issues require special data type considerations to be made due to biometrically inferred data now being extracted using AR/VR devices. AR/VR devices can generate and process large amount of highly personal data, including metadata and health inferences across various geolocations. The council has started the work towards expanding the definition of personal information that must be portfolio architected including biometrically inferred data, psycho-graphically inferred data which is especially prevalent in the AR/VR data pipelines.

But along with these new opportunities come new risks. In order to create safe healthcare ecosystems, the council has established that a multi-pronged approach must be taken.

First, all stakeholders must share the responsibility for education and awareness around the risks and the opportunities for all stakeholders, including patients. Secondly, there needs to be a global oversight and harmonization of standards and regulations to enable control over massive amount of patient data being harvested by AR/VR.

Finally, I would like to put forward three major recommendations from the medical XR advisory council to the FDA. Number one, help improve upon current medical standards to incorporate AR/VR technologies. Number two, help create awareness and education around risks and opportunities for all stakeholders. Number three, enable standardization and regulatory enforcement across geopolitical boundaries that include FDA, CDC, NHS, HHS (indiscernible). Thank you for allowing me to represent the medical XR advisory council and

thank you for all the great work you do to protect human lives.

Once against, my name is Kavya Pearlman, and my information is available for any further correspondence or questions you may have for the council.

MX. SCHWAB: Hi there. My name is Michael Schwab, although I currently go by the name Emmy, and I use the pronouns they and them.

Thank you to the CDRH for holding this committee and offering me some time to speak at it regarding virtual reality and augmented reality or XR, if you want to call it that. I'm a proud enthusiast, practitioner and ethicist. I'm also a mental health advocate, I've been diagnosed with major depressive disorder at 32 and in that space of time I've undergone various forms of treatment both inpatient and outpatient, this including psychodynamic therapy, cognitive behavioral therapy, pharmaceuticals, a broad range of pharmaceuticals and electric compulsive therapy, around 12 treatments. From my own experience with the technologies of XR and its associated applications, I feel a great deal of hope at the prospect of completely novel, experiential, and interactive treatments of a broad range of mental illnesses.

My fear however is that these treatments outside of a research setting or a more service-oriented models will be available to the public through apps on app marketplaces that do not have a formalized mechanism for quality control and user safety. So, I'm using this time to advocate for the acceleration of a regulatory system that keeps the safety of the patient and the efficacy of the treatment as its unwavering north star. However, since such a regulatory system be voluntary in the form of you know a self-declared designation, it must share itself to the fast moving and highly iterative nature of the software development cycle should it be adopted at a wide scale.

How this regulatory system will be designed, adopted, and enforced I leave up to the

committee but stress again the need for acceleration. The use of the term wild, wild west is already being used to describe the nature of the industry and while I feel that this moment is a beautiful time for innovation and experimentation, the philosophy of moving fast and breaking things must not continue to be grandfathered in. Again, I thank you for your time and I thank you for the work that you do. Emmy, they/them/me, take care.

MS. DAGA: Hi. Good afternoon. My name is Shweta Daga. I'm an executive, regulatory and quality leader with over 14 years of experience within the regulated industry. I'm currently part of MDIC, medical device extended reality workgroup, as one of the industry representative volunteers. I'm also currently leading regulatory engineering, compliance and operations, function as Align Technology, as director of regulatory affairs.

Today I'm here to express my views on the issue pending before the committee, that is augmented reality and virtual reality medical devices, and their now attributes impacting the end user and the evaluation of the device, safety and effectiveness tied to the end user contribution. I would be specifically speaking on the topic the importance of patient perspective and early patient engagement for evaluating the benefits and risks of medical extended reality devices.

Really quick, my disclaimers here for the record. So, between yesterday and today as we have heard, and there's a lot of information out there as well, augmented reality and virtual reality medical devices are cervical rating the use of immersive technologies for healthcare consumers. There is no doubt that AR/VR in healthcare has opened many new opportunities for healthcare professionals and is a promising technology from a modern health organization perspective.

AR/VR development in use and target pediatric and cognitively impaired population are

moving rapidly and so are the unique challenges due to the novel attributes of digital health visualization, tracking techniques, embedded software, and unknowns in the premarket evaluation space. Hence, these technologies require patient perspective and early patient engagement for a seamless transition even more than regular digital health technologies would typically require.

Now we've heard you know from many industry experts and FDA experts here that the AR/VR devices have the potential to be used in many areas, whether it's a surgical space or understanding patient's condition better, relieving pain, providing surgery simulators for training medical practitioners or training surgeons for actual surgery or using it as one of the tools by the teaching centers or the students to give them a more real life training experience. The biggest bucket that we have today in front of us that needs more and more patient engagement is the diagnosis and treatment of health conditions of patients.

Having said that, it's really important to see a user centered design approach in the context of AR/VR devices. Now AR/VR devices require a user-centered dine especially considering that the target patient population is inclusive of pediatric and cognitive impaired patients. AR/VR dices are novelties and they come with a key challenge associated with these devices directly related to use and user driven risks in addition to standard medical device, risks coming from hardware, including display technologies, physical environment and software failure modes.

To evaluate these risks as a patient centered device, there is a need to clearly define premarket post market evaluations that are inclusive of patient early engagement. Now in my opinion patient centered design during device development can occur at any point during the AR/VR device's development process. Early patient engagement for a premarket evaluation

may be incorporated as equal partners with the designers at the beginning of a project instead of patient input obtained via usability testing only during the final stages of the design which would be validation stage of the design.

The AR/VR device design process shall also include the needs of the environment and the other users of the ecosystem like family members, caregivers or guardians and this need is even more critical for AR/VR devices because of their home setup use and the close engagement between the user, the ecosystem, and the device itself.

Let's talk a little bit about real world data and privacy and its role in the AR/VR design input setup. AR/VR devices come with a unique user privacy challenges due to the scope, scale and sensitivity of the information collected by these devices. This information is the core function of the device because this is the information that helps the device to function as intended. The immersive nature of AR/VR makes it difficult to mitigate risks by applying current privacy policies and medical device practices from other digital health technologies that are available on the market. AR/VR devices require new ways to manage transparency, choice, and security.

Now we cannot forget the critical role of post market evaluation within the space of AR/VR medical devices, which is true for most of the medical devices, but AR -- but post market evaluation has a special role within AR/VR medical devices evaluation process. This evaluation of AR/VR devices can benefit significantly from a dedicated real world data collection program as the patient feedback can provide critical design improvements or identify future device generations that cannot be done in a premarket setup.

Having said that, thank you so much for giving me the opportunity to express my views on the key importance of engaging patient early in the process of AR/VR design development and

having more patient perspective in the whole process and the total product lifecycle to mitigate risks and have the benefits outweigh the risks. Thank you so much. For any questions I can be reached at this email address. I'm also available right now to answer any questions that the committee may have for me. Thank you.

MR. HOLZBERG: Reimagine Well was founded in 2016. Our company's mission is to develop empowering programs that immerse patients in unique experiences, leveraging content, technology, education, and imagination to improve their journey. My cofounder is Dr. Leonard Sender, director of the Chan Soon-Shiong Institute for Medicine.

I'm Roger Holzberg, a former vice president, creative director at Walt Disney Imagineering, and the first creativity director at the National Cancer Institute. Our presentation today is on Reimagine Well's experiential education programs. We'll give you a brief overview of three of these programs, beginning with the radiation experience, then EEG, and ending up with our MRI stillness game. My co-presenter is Debbie Wagers.

MS. WAGERS: My name is Debbie Wagers and I'm the child life supervisor at Boys Town National Research Hospital. Early in my career I developed the one voice approach. The goal is to teach healthcare professionals how to create a less threatening environment for children undergoing medical procedures, and it's been implemented in more than 200 hospitals worldwide.

In 2019 Roger and I both presented on an innovation panel at the association of community cancer centers conference. Soon after, we began developing programs for experiential education for pediatric patients. The problem I was having was the oversedation of pediatric patients due to anxiety, and as a child life specialist I knew if I was able to help children experience the procedure firsthand, this would decrease their anxiety and likely lead to

their being able to complete the procedure without sedation. The program we developed is graduated so that patients can use it without a VR headset because about one-third of them are not comfortable with a headset on.

This is an exact replica of our clinical room. Our ongoing IRB study with this program has shown some excellent results. When I use this VR experiential education program with my pediatric patients, I always began by letting them explore the room with the Xbox controller, flying around up high so that they feel safe.

Once the patient is comfortable, I ask them to use the Xbox controller and drop down to kid height where they can walk around the room to further explore it. If the patient is scheduled for standard or cranial radiation, they will approach the radiation table. When they're comfortable, they will select the treatment that they will be having. For this simulation we'll select cranial.

I remind them about the mask, how we made it and practiced putting it on earlier. I let them know that we will be able to see them the whole time and they will be able to hear us and talk to us if they want to. We practice lying very still, ending the simulation when appropriate.

Hello. My name is Macy Conners and I'm a child life specialist at Children's Wisconsin. I always start with "welcome to our EEG hall of heroes." On each of the walls are pictures of some of the patient heroes who have been here before you. Using the Xbox controller, they are able to select each of these pictures. Hidden behind one of the pictures is an Easter egg. Finding the Easter egg earns them a special reward. Are you ready to go into the EEG room?

Let's assume our patient is ready to go and selects yes. I always begin by letting them explore the room with the Xbox controller, flying around up high so that they feel safe. The parent or caregiver is always able to see the simulation on the laptop screen. We've found that

reducing the anxiety of the parent always helps reduce the anxiety of the child as well. There is another Easter egg hidden behind one of the animal pictures on the wall. Are you ready to begin your EEG exam? The patient answers yes.

The patient manages themselves laying back on the bed. The safety arm is raised into place and the bed is pumped higher. Now on the bed they are able to look all around the room again. Back behind them is the cart that will be use for the EEG exam. When the patient is ready to play the EAB game, they select the cart.

And now the scavenger hunt game begins. Becoming the clinician, the patient uses the top of the cart and all of the items on it to perform an EEG exam on a video version of a child teaching mannequin. The goal of the game is to get the child and their parent or caregiver familiar with all of the items that will be use in their exam with a hands-on understanding of what the items are for and how they will be use during the procedure. Once complete, the patient has the option to replay the game or go back out into the hall of heroes and virtually meet other kids who have led the way.

The MRI stillness game is the first of its kind in the country. Little a 20-minute virtual reality experience that helps children to see what they're going to be doing and practice for an MRI before they experience the test. One thing that we are trying to combat within the MRI stillness game is fear. Many children and adults when they're exposed to a new circumstance that they haven't experienced before, they can develop fear. Using three increasingly difficult scenarios, the children are trained to focus on an image that helps to eliminate the noise of the MRI, helps to overcome the claustrophobia, the enclosed within the similarity and this helps them to you know do what we need them to do in the MRI.

Ian is receiving radiation treatment for an alveolar retinal sarcoma of the arm and the

axilla. He has now received three months of chemotherapy, surgery and is now receiving proton radiation to help prevent this cancer from coming back. Because of the amount of time that we need patients to remain still, many of our youngest patients like Ian need to undergo anesthesia to have their MRIs.

Using the MII stillness game may help our young patients to be able to receive their MRIs without anesthesia. And this means that they can happen much more easily and much more quickly.

>> Our early learnings have told us that the mean age of sedation can be significantly reduced and the clinical team members participating in the study support the use of the program. With the EEG game, that the mean age of sedation and apposing can be significantly reduced, and with the MRI stillness game, preliminary results have shown that the pre-procedure acclimation can significantly reduce the duration of the procedure. Thank you for your time.

DR. TAWFIK: My name is Dr. John Tawfik. I'm the director of clinical services with Accelerated Care Plus. I would like to thank the Patient Engagement Advisory Committee for the opportunity to provide these comments. In the form of introduction and disclosures, again I am employed by Accelerated Care Plus or ACP. ACP is a renal based company which is part of Hanger Eight based in Austin Texas. ACP is a clinical solution company which provides a number of clinical education in post-acute care settings as well as develops a number of rehab technologies including virtual reality, surface EMG and biophysical agents, among others.

I'll focus my verbal comments here on virtual reality and rehabilitation services provided by physical therapists, occupational therapists and speak language pathologists. Due to the limited time of these verbal comments, I will focus then on reviewing the evidence for VR in neurological, cardiopulmonary and dysphasia, or swallowing, clinical areas. Additional

comments that were submitted in writing by my colleague, Dr. Rich Engleman and myself will expand on other areas including full prevention, orthopedic, pain management, wound healing, and continence improvement.

Over the last 20 years and particularly more recently in the last five to ten years the use of VR in rehabilitation services have dramatically increased. The benefits of VR include increased patient engagement and motivation which in turn has an impact on the exercise intensity, longer duration of exercise and more reputations. This has a physiological impact which enhances neuro plasticity and cortical arrangement in response to task-oriented type of movements. VR also allows for simplifying complex movements and tasks into components that appropriately challenge patients. VR acquired skills have been shown to carry over to real life settings. So, the benefits of these repeated exercises and longer durations do have impact on the quality of life and the functional performance for these patients. VR devices that are designed specifically for rehabilitation offer the following benefits compared to off-the-shelf type of technologies that may be fitted or retrofitted for rehab.

Virtual reality specifically designed devices have preset as well as adjustable parameters to individualize the exercise for the patient's specific ability. They respond to the patient performance by increasing the difficulty level so that they continue to challenge the performance of the patient. They provide positive and frequent feedback which provides that performance of results, encouraging the patient to do their best and to continue to accomplish new levels with that exercise.

And then finally they're often allowing for both individual type of performance or a group type of activity with another patient which creates a sense of competition specific to VR and neurological rehabilitation a 2020 clinical practice guideline looking to make clinical

recommendations for improving locomotion function in patients with chronic stroke, in complete spinal cord injury and brain injuries did find strong evidence to indicate that walking training with moderate to high intensities as well as virtually based training should be offered to individuals that have had stroke six months or greater.

On the other hand, there was also strong evidence that suggests that body weight supported treadmill training, robotic assisted training or sitting and standing balance training without VR should not be recommended for those individuals. Additionally, a number of systematic reviews found similar results with the use of VR. Systematic review found that subjects with spinal cord injury who use a VR based rehab may lead to positive effects on aerobic function, balance, pain level, motor function recovery besides improving the psychological and the motivational aspects.

In another systematic review which included 97 articles, additional benefits were gleaned from VR in neuro conditions in addition to the benefits from conventional therapy alone.

In the areas of pulmonary and cardiac rehab very similar benefits with VR compared to conventional therapy alone. A third area to review is the effects of VR on dysphasia and speech. A couple studies that are cited here specifically focus on dysphasia or the difficulties enunciating or pronouncing words. This randomized control trial which had two groups that use VR and another group that did not found while there were no differences in vocabulary related changes in both groups, the patients that use a rehabilitation gaming system for chronic dysphasia did improve language and communication whereas the traditional group did not.

A recent patients success anecdote to share is the use of spirometry VR exercises. So, a patient would use spirometry breathing exercises and be able to see on a screen those breathing exercises in a virtual environment. Patient was a retired opera singer where after a

course of treatment three times a week for four weeks was able to finally regain the ability to have better breathing capacity, and once again sing for her family members and loved ones.

With that I would like to thank the committee once again and take any questions that you may have.

MR. CONWAY: I would like to go ahead and thank all of today's open public hearing speakers. We very much appreciate your willingness and courage to share your perspectives with us today.

I now pronounce the Open Public Hearing to be officially Closed. We will proceed with Today's agenda.

We will have open committee discussion and clarifying questions from the committee. As a reminder, although this portion is open to public observers, public attendees may not participate except at the specific request of the committee chair.

Additionally, we request that all persons who are asked to speak identify themselves clearly at the time for the transcriptionist.

Let us go ahead and begin, and I'll go ahead and ask my committee members to raise their hands if you have any clarifying questions for the FDA moderators of the Virtual Breakout Sessions or the Open Public Hearing Speakers? Committee members, please turn on your video monitors, unmute your phone, and state your name when you speak.

You can raise your hand and I will call on you. Thank you. Let's go ahead and start. And we'll go ahead and start with Amye Leong.

MS. LEONG Thank you. Thank you very much. My particular thanks to the seven individuals, I think eight or so, who participated in this morning or today's open public hearing. I'm going to ask a broad question, and for those of you for which this is relevant, please

respond. And of course, patient engagement is at the heart of what we are talking about here, but the process of virtual and augmented reality is a very, very exciting field so my question is specific to those who are developers or participated in development projects that resulted in a product test or a demonstration alone in AV or AR situation. How difficult was it for you and your company to secure patients to engage in the development process? And if you can elaborate on that a little bit, please. Anyone?

MR. CONWAY: Let's go ahead and start. Raise your hands. Let's go ahead and start with Dr. Joe Morgan.

MS. LEONG Thank you.

DR. MORGAN: Hi there. So that's a great question and when we started about six years ago, we had a very initial prototype, proof of concept, and my initial testing was frankly with family members and friends. And we as a company are addressing things that tend to be more common, such as anxiety, pain, and so forth. And you know everyone ultimately is a patient at one point or another during their life so that's where we started.

My story is a little bit more particular, my mother suffered from Alzheimer's and she unfortunately passed away due to coronavirus in August of 2020, passed away kind of by herself in a retired -- in a nursing home and you know but I have memories of sharing with her experiences using virtual reality and recollections of all the Joy that it brought to her because frankly at that stage just prior to when she went into a nursing home, she really still wanted to go back to Italy and so this was a great opportunity for her to experience that. So, I guess the overarching point is that you know the initial testing, six years ago or thereabouts was really you know finding folks that were willing to try. That was step one. And then really based on the individuals that were willing to try it and able to try it and based on the use case and the

design of the particular implementation, going from there and trying to get as much information and feedback as we could to serve as a base upon which we iterate.

MS. LEONG Interesting. Anyone else?

MR. CONWAY: Dr. Ward, hold on one second there, Amye. We'll go to John Tawfik and then we'll go to Mr. Holzberg.

DR. TAWFIK: Thank you very much for the question. My name is Dr. John Tawfik. I'm a physical therapist. And in our experience and in our work, the development of virtual reality is often used in a clinical setting and oftentimes an assisted living or skilled nursing facility settings so that really enables us to make the voice of the customer an integral part of the software development.

The virtual reality is often done as part of the intervention session or rehab session with PT, OT, or speech. And we, in part of the gate process, listening to what is the unmet need that is developing the initial software, and deploying it in this setting to really see that it does meet that unmet need, as well as make any modifications in the software on an ongoing basis. So, one of the beauties of this is that it certainly allows for the continual evolution of what does that software look like in order to really be on target, be engaging to the patient and yield the best outcomes possible.

MR. CONWAY: Thank you, Mr. Tawfik. And in response to you, Amye, you also have Mr. Holzberg.

MR. HOLZBERG: Yes, thank you for the question. Yeah, very briefly, we always work with clinical partners to develop solutions for problems that they are having in clinic and never develop a product just because we believe it would be an interesting product. So, one of our clinical partners who works with us as an adviser, Debbie Wagers is here with us. The specific

problem that we addressed for her, we developed a prototype and then bringing with us principles that you know I practiced for the brunt of my career at Walt Disney Imagineering prior to becoming a patient and going into healthcare, was rapid prototyping, rapid prototyping, rapid prototyping. Putting it in front of Debbie, her team and her patients in storyboard form and being sure that we were addressing her clinical concerns before we ever began development.

MS. LEONG Very good. Thank you.

MR. CONWAY: Did that answer your question, Amye?

MS. LEONG Yes, very much.

MR. CONWAY: Okay. Other questions from committee members to either the FDA moderators or to our open public hearing session? Go ahead, Bennet, and then we'll go to Omer.

MR. DUNLAP: So just following up on Amye's point. I would strongly urge the developers here and any listening in to go back to previous PEAC meetings where there were discussions on what constitutes real patient engagement in medical research. We had a whole meeting on it. But specifically, the design from the outset with patients who are not investigators and investigators or family members. I just want to reiterate that and encourage people to go back and look at those meetings because I think Paul did a great job moderating them.

MR. CONWAY: Thank you very much, Bennet. Let me go ahead --

MR. DUNLAP: Any time.

MR. CONWAY: Thank you. Let me go ahead and move to Omer and then I would like to ask Heather to speak also. Go right ahead, Omer.

DR. LIRAN Hi, this is Omer Liran. My question is reading the pediatric use of virtual

reality for procedures. What specific obstacles were faced for the pediatric population, and during the development how is it different given that we are dealing with a very vulnerable population? Thank you.

MR. CONWAY: Yeah, one of our participants would like to address that.

MS. WAGERS: I think I would probably be able to answer that for you a little bit. My name is Debbie Wagers. And I suppose one of the bigger obstacles is when you look at when virtual reality, the ages that that -- that those ages of children it's been approved for generally says ages 12 and older. Doesn't mean or if they don't have any you know like a seizure disorder or anything like that. So how we kind of got our -- worked our way around that, it was just solely up to whether or not the parents gave permission, if the children gave permission. As long as they didn't have a seizure disorder or anything like that, we were able to -- able to work around that.

And we really found that the challenge that I always faced and what I took to Roger was in order to help acclimate children to the environment and to help kind of desensitize them to what they're going to be encountering you as a child specialist you want to be able to take them to that specific area and introduce them to it, let them explore and all of that but we can't do that because those areas are always being utilized clinically so that's where Roger and I partnered to be able to provide that for them in a virtual sense. And the beauty of the program that we developed was that the kids when they're looking through the VR headset everything that they are seeing that we are also seeing that on a laptop. So, the parents are also able to experience that fairly firsthand because they're the once that are having to field those questions for the kids once they leave there. Probably the only other obstacle that we had which was fairly easy to overcome because it is kind of a dual system is younger kids often don't

want to put on a VR headset. The VR headset is scary for them, but the VR headset has a little flip-up so you can hold the headset and they can put their head up to it and look through it and mom or dad can show them it's okay. Or we just do that whole experience on a laptop, and they can still experience it firsthand. It's just not nearly as immersive. So, there's a lot of power in being able to take them there in a virtual sense that acclimates them so when it's time to actually go into that room, they're kind of like hey, I've already been here.

MR. CONWAY: Great. Thank you very much. Just as reminder for everybody, in this process – this is the process where the committee is asking the questions, and I would ask my fellow committee members to direct your questions to specific speakers. This is not an opportunity for open public hearing speakers to ask questions of the committee, so just to be very clear.

So let me go ahead now and actually ask Suz to go ahead and pose a question. Suz, if you could let us know who you're posing the question to.

MS. SCHRANDT : Yeah, thanks. Suz Schrandt. Actually, it might be to more than one person, so I think anyone who spoke about technologies that are less focused on the direct patient experience and more focused on tools and functionalities for clinicians. And this kind of picks up on what Bennet and Amye have already spoken about. I think it's a little bit easier to think about patient engagement and how to partner with patients, and we heard some good examples, when you're developing VR or AR for a tool that patients will use. But I'm curious about any of the speakers' experiences when you're developing technologies for clinicians to use that are much more related to the clinical workflow, it might feel more attenuated. It might feel like the end user is the clinician, but I maintain the end user is still the patient. And so how have you worked with patients, or have you thought about patient engagement in

those modalities where it's a little bit more difficult to think through? And again, I think one of the areas that's most -- maybe has the greatest area of opportunity but also the greatest area of concern is anything related to training of clinicians. This might be an opportunity to really get it right, where traditional modalities haven't gotten it right, so what could we do in the VR space to really make sure patients are engaged in those tools.

MR. CONWAY: Thanks, Suz. Let me go ahead and ask Dr. Morgan to take the first swipe at that. Go ahead, Dr. Morgan.

DR. MORGAN: Yeah, thank you for that question. I think first of all you know in terms of identifying problems and not you know going after -- having a solution and then trying to find a problem instead of you know we don't run into that problem too much because we ourselves are clinicians and so we see the problems on a day-to-day basis and we're intimately familiar as to what those are. And I'm an extremely strong advocate for the inclusion of providers at all stages of development process. And to clarify a previous point you know we have our applications in use across the country at over 60 hospitals so you know although in 2016 and shortly thereafter there may have been plenty of design and rapid prototyping with folks that were readily available, aka family members, those are different evolutions of the technology. But you have to start somewhere. And so, I think in all honesty it would be disingenuous to say that anyone started at, you know, we went from zero to a randomized controlled trial.

Now, you know we're in a different realm now obviously and things are clearly accelerating. But back to your question I think you know it's just really critical that the provider have a role. We are foreign natural, I myself am also a developer and so that sort of domain expertise comes in handy but you know it doesn't have to be people with multi domain expertise but you do need to have all of the different experts at the table in order to be able to

really bring the technology forward in a way that is going to be advantageous for providers.

And in terms of the provider engagement, I completely agree that the patient is the end user. The patient is the focus. But with all of that being said, if it never gets use, it's never going to help anyone and so it's absolutely critical to have you know something that's certainly not going to add to the day-to-day burden of a provider in terms of you know all the other things that they have to do. And what we're really interested in, and there's great promise for this technology, is to create efficiencies for providers, to actually make things easier in their day and to really open up more time for direct patient to provider conversation, answering questions and those sorts of things.

MR. CONWAY: Great. Thanks, Dr. Morgan. Hopefully, Suz, that's answered your question let me do this. I have two open public hearing speakers who would like to make a comment to one of the questions. What I would first like to do is have our committee members be able to pose questions then I'm come back to you. So let me go ahead to Dr. Monica Willis Parker Go right ahead, Dr. Parker.

DR. PARKER: And this is to any of the developers. I'm hearing several recurring things from the consumer side, and I didn't hear as much of this addressed from the developer side. There were issues I mean I guess I'm posing this more to Dr. Morgan. As a clinician I applaud having clinicians involved in the development and certainly being involved in the training of how to use whatever device it is for whatever part of medicine they're using it for. But what I didn't hear number of, and I heard it from the discussion groups was how are we protecting people's information and privacy and as it relates to development, a lot of these devices are not necessarily covered by insurance, and how you know in the era of diversity, equity and inclusion, I'm so tired of hearing it now, we talk about it but we don't really pay attention to it.

So, I'm going to buy a device for helping my child with her moods, whatever, and I don't know whether it's going to be useful for five years, four years. It's something that might help my child, might not help my child. It's not covered by insurance. At what point do we have buy-in from insurance companies and governmental insurance companies to cover the cost and development of these things?

MR. CONWAY: Let me go ahead and ask Ms. Pearlman to give a comment on that and then also Mrs. Holzberg.

MS. PEARLMAN: So, thank you everyone and thank you for this opportunity. Monica, I share your concerns. I am the founder of XRSI. We have a medical XRSI council, and we'll been investigating these very issues. Our mission is to help both safety and inclusion. So, since 2020 we have been working together with British Health Services, and we've arrived at potentially a shared responsibility model so when you formulate these solutions, there needs to be responsibility from the provider side and in what context does the provider need to own up to that responsibility? And then in certain context this responsibility is of the insurance provider or is off the patient itself to be watching out for certain mechanics. And it's really just contextual. In some context the entire responsibility could be off the manufacturing device provider, so these are things that have to be looked at granularly. I'm proud to say that now there is the group MDIC you know that is currently really granularly looking at these things and of course we are contributing to it. But we are way behind on these things. And I think FDA really has a tremendous opportunity here to even go across the trans-Atlantic and collaborate with NHS that is currently working with us to potentially bring together some kind of a global system because my background is cybersecurity. And in the cyberspace in the so-called metaverse the 3-D internet there are no GEO political boundaries. People can receive -- you

can do coordinated assisted surgeries across like from Israel and something stuff like that, so this is something very unique that we got to address here and that is you know going to require this multi-disciplinary panel of experts including clinicians, including patients. Unfortunately, there is no you know ready answer right now, but we are working on this sort of research with the medical XR safety and privacy framework which home happy to put forward and share with anyone who is interested to potentially work together on.

MR. CONWAY: Great. Thank you very much. Heather, I'm coming to you, and I appreciate your patience. Ms. Scarato, do you want to respond to Dr. Willis Parker's last question?

MS. SCARATO: Actually, I wanted to respond to something earlier.

MR. CONWAY: I know that. I appreciate your patience. I'm just trying to roll through here. Do you recall what the question was that you wanted to respond to?

MS. SCARATO: Yes, it was about children's vulnerability and the development of technology for our developers because we are advocating for and have a list of you know, safer ways to make technology without the use of radio frequency radiation because there hasn't been federal evaluation of the impacted children's brains. And also, specifically when it comes to children's eyes. I think this is a really important issue because they're still developing and have different protections until you're actually an adult in terms of the kind of light that is allowed into the eyes as well as of course the impact of radio frequency which has not been addressed by any federal entity in terms of what would the impact be of radio frequency to children's eyes so using devices that are wired, rather than emit radio frequency is one way that you can develop safer technology.

And also, children's brains and bodies, you have more stem cells, active stem cells and

research has zone that stem cells are actually more impacted by radio frequency microwave radiation.

MR. CONWAY: Great. Thank you very much. Just as a reminder to our committee members, if you can keep the focus of your questions within the scope of the presentations in the outline today, I would appreciate it.

I'm going to go to Heather Adams now and ask Heather to go now. Emmy, I see your hand up and also, I have a question for you. Go ahead, Heather.

DR. ADAMS Hi, this is Heather Adams. Thank you so much to the presenters. I learned a lot by hearing all of your different perspectives. I have a few questions that are pediatric focused so this question will go out to presenters who address pediatric issues or issues for other vulnerable populations. Several of them are highly specific.

I was curious about what types of screening would be recommended for children or other vulnerable populations above and beyond risk procedure and how you would determine that someone would be you know would be safe and appropriate to use AR/VR approach. I was specifically curious why in one of the demos that we were shown it was stated that being able to fly up high makes you feel safer. I was curious to know where -- you know what was the basis of that. I was also curious whether you know there was good discussion and presentations addressed the ability for parents or other proxies to be able to monitor and be able to pause or limit access or limit time with devices and AR/VR experiences. But I wondered about the patients themselves and their having the ability of the agency to stop something themselves or manage it themselves particularly for children or other vulnerable populations.

And then the last question is a broader one, again for children. Is -- for development -- you know because of developmental level issues, the development of a

3-year-old is vastly different from a 6-year-old or a 16-year-old, what are things that augmented and virtual reality maybe doesn't do well for pediatric populations? And in what areas should it not be use and why?

MR. CONWAY: Thank you very much, Heather. Would one of our open public hearing speakers want to address that or one of our FDA moderators? Did you name a specific person that you directed your question to, Heather? It sounded more open.

DR. ADAMS I'm sorry it was open, but it was for anyone who talked about perhaps pediatrics as a start would be a place to begin.

MR. CONWAY: Okay. Why don't I go ahead and turn to Emmy and ask Emmy if you would like to go ahead and address that. You're muted, Emmy, thank you.

MX. SCHWAB: As far as I know most headsets are not recommended for use for anyone under the age of 12 or 13 so I would be really curious about any research that's being pushed for anyone under that age. That's just where I would start. I also, I didn't get a -- you know I did have my hand raised for Monica's question. I don't want to go backwards but I think it's a very important question that ties to a lot of the other questions that are being asked.

MR. CONWAY: Go ahead.

MX. SCHWAB: And I'll just put that forth. I don't want to derail the conversation.

MR. CONWAY: Okay. I appreciate it. I can come back to you, Emmy. I have a similar question for you in a bit. Let me ask Ms. Pearlman to go ahead and address that question and then we'll move to Philip.

MS. PEARLMAN: Sure thing. Thank you. And with respect to children's safety, we are actually investigating at the council, so my colleague, Dr. Valentino McOllie, he's a pharmacologist and he is currently doing research to do pain mitigation use AR/VR for children.

As a baseline what we recommend we should look to ICO U.K.'s recommendation, they call it age-appropriate design consideration, where they have laid down various age groups. And from that age group we need to conduct further research with respect to impact on the brain for neuro marketing, impact on the brain for certain other, you know -- the conversation was about the impact from signal perspective, et cetera. This is an open area of research. We don't have enough data to assert these recommendations from a clinical medical perspective. I do know that senator -- one of the senators -- I'm forgetting the name, sorry, I'm recovering from COVID just now, but the Camera Act, C-A-M-E-R-A, Act was put forward to specifically investigate these issues. It included advice on that, so it included virtual augmented reality so the implications on children's health from these technologies including artificial intelligence, that bill is still sitting and not moving anywhere. It would have freed up $25 million to NIH for that very specific research and presented report back. So, we need this kind of intervention to come up with the responses, so we have more questions than answers. So, at the moment I see your case, age-appropriate design consideration is the only baseline we have.

MR. CONWAY: Thank you very much, Ms. Pearlman. I tell you what, if you could hold on one second there, Philip. Mr. Holzberg, you had raised your hand also, I believe in answer to Heather Adams' questions.

MR. HOLZBERG: Yes. So quickly, just Heather Adams, you asked very specifically about flying up high. And I think it's really important for experiential education programs to embrace the language that pediatric patients all under 20 seem to understand which is how to drive an Xbox controller and how to use it in a game identified versus an exploratory environment and it also addresses the sort of age barriers and age differentiation. We found that the younger patients may want to just explore, not being in the proximity and therefore having to interact

with the medical devices in the room for a longer period of time than the older patients might want to -- might want to. They may be ready to jump down at normal kid height and engage immediately, so that's why the up high, and that also -- including that also enables the younger and the older patients to use the same application in ways that are appropriate to them at that moment in time.

MR. CONWAY: Great. Thank you very much, Mr. Holzberg. And Philip, thank you for your patience. We'll go ahead and ask Philip. And then Teri, I see your hand up as well. And Philip, if you could ask a specific question to a specific speaker that would be helpful. Go ahead.

MR. RUTHERFORD That might be challenging on the specific speaker because it is kind of a general question. We'll take the first person to respond. How about that? My question is around screens, specifically around substance use disorder. We know that people with substance use disorder sometimes have a predisposition to other types of addition, and I'm curious if in the development of any of the XR environments if there's been any work looking at possible addition, if there's been any research in that space. And I did have a second question, but I suppose I can hold that for a different time.

MR. CONWAY: Thank you very much, Philip. Emmy, your hand is up first. Go right ahead.

MX. SCHWAB: Yeah. So as someone who is in recovery myself, I just -- I have to say that I mean, we just have to look at addiction to our phones to imagine what the addiction will be like in VR when you're talking about an immersive environment where you might lose track of time and space in your what I call it you know your bio terrestrial reality. I think for the right person can be highly addictive especially for those people who have quote unquote addictive

personalities and also for people who will find that environments in virtual reality are a lot less unfriendly than their environments in their actual reality. So, I think it's something very much to consider. At the same time there's also recovery happening in VR, but does it have the same level of anonymity that you might have on a quest two where you need to be connected to a Facebook account, so there's a lot of considerations around addition to the technology itself how it applies to folks in and out of recovery.

MR. CONWAY: Thank you very much, Mr. Schwab. And Mr. Tawfik, I see your hand up in response to Mr. Rutherford so can you go ahead?

DR. TAWFIK: Sure, thank you. So, I think considering generational differences and the patient population that is targeted is key in this aspect. So, from geriatric patient perspective, we find that engagement with a screen based on XR type of virtual reality increases the intensity of exercise in properly dosed therapy to actually have a very positive outcome when the default position is to perhaps do too few exercise repetitions or lesser engagement in rehab activities. So, I don't think -- although research currently does not point to any potential addition, but rather to increase the engagement in a geriatric population that would make the results of a rehab program more meaningful.

MR. CONWAY: Great. Thank you very much, Mr. Tawfik. Let me go ahead now to one of my fellow committee members, Teri Diaz. Go right ahead.

MS. DIAZ: Hi, thank you. So, my question is open to anyone as well. I just am curious if there is any long-term data on adverse events with the VR units for pediatrics?

MR. CONWAY: Let me go ahead and ask Ms. Pearlman.

MS. PEARLMAN: So here is the issue with research data, and that applies to geriatric patients as well as pediatric. We are -- and I'm going to refer to this terminology that applies to

several different technologies including nuclear energy, et cetera.

What we are facing here is something called Escolenridge (ph) dilemma. And the technology, it is a two-bind problem where you cannot necessarily address the consequences of the technology until it is fully developed, and we are talking about the mixed use of AI with the AR/VR ecosystem. And by the time it is fully developed, it would be too late to undo the consequences when the risks that would materialize which is why while we are looking at, let's say, research, but we need to anticipate some of these consequences and risks and not go ahead and move fast together with the you know PH*ET philosophy to say oh, we're seeing these fancy results, let's go for it, and that's what I would like to caution is just because we are only looking one way with our biases, there may be this other impact which is more consequential. We have seen that happen with cigarette sales where it was just you know benevolent paying and the sales were all going on.

But at the end of the day FDA literally had to intervene and we had to come up with committees and stuff but already people were kind of addicted to these, the tobacco sales. So, we're seeing that very similar writing on the wall here where people have decided to move fast towards this technology, but we have not curated and collected enough research to be pragmatic about these decisions, and that's what I would like to assert. And unfortunately, I do not have any research at hand to share with respect to pediatrics.

MR. CONWAY: Thank you very much, Ms. Pearlman. And we have several other answers for you, Teri, on this. And I would like to go ahead and ask Ms. Scarato to answer first, briefly, Mr. Tawfik, and then Dr. Morgan, so if you can keep your comments brief. We're trying to stay within a certain allotted time, so Ms. Scarato, go right ahead.

MS. SCARATO: Thank you. I was going to address actually -- it applies here as well but the

issue of exposure of radio frequency paired with drugs in the system and what research has been done on that, because there is certainly research that shows a synergistic effect, an additive effect from nonionizing radiation and other environmental or chemical or drug exposures. And also, the issue of metal in the body, which really needs to be addressed as well as metal in the mouth or even metal on the body but when there's metal in the body if they're going to be screening, for example, related to metal. And when you think about situations if there's not proper consumer safety information where education there's maybe a router and a cellphone and a bunch of wireless devices surrounding a child in a clinic or something and they're not adequately addressing where those devices are and the exposures to the children. Thank you.

MR. CONWAY: Great. Thank you very much. Mr. Tawfik?

DR. TAWFIK: So, I'll make my comments very brief. I think again specific to my area of expertise for geriatrics, we found that these screen-based extended reality are far more effective than a head mounted device not only from ionizing type of exposure but also from cyber sickness risks. So, we've actually limited the vast majority of VR interventions in a geriatric population for rehab interventions to be large screen based where it's for augmented part, that mixed reality, the patient and their caregiver or the patient and their treating therapist are immersed in that environment. So, in that type of mixed reality or extended reality, these negative effects have not been observed.

MR. CONWAY: Thank you very much. Dr. Morgan?

DR. MORGAN: Yes. Thank you for that. So just with regards to vulnerable populations globally, I think the age question is very important and as somebody astutely mentioned that the device manufacturers tend to say 12 or 13 as an age. I think with regards to the evaluation

of pediatric implementations, I think it's absolutely critically to incorporate the impressions of parents into that evaluation process because they know their children better than anyone else.

I think certain features are critical for making this technology accessible to vulnerable populations. And what I mean by that are actually software features like for example if somebody is unable to see in low light or somebody has visual impairment, there are different features that can be built into the software to for example magnify images and enable accessibility for these populations.

I think that sort of exit button or you know an end session button both on the provider's side as well as within the headset for the user is an important safety feature. And then other enabling features such as screen casting so that the providers and/or parents can see what the patient is actually doing.

And one last point about AI. It was mentioned, and I think it's critical to understand that you know today's augmented virtual reality technology is really required AI frankly. It is advanced in computer vision that have enabled this technology, so you know it's part of the DNA of this technology. And so that was a very good point that I want to emphasize, that you know there is just an enormous amount of data that is being generated, and I think it's a common theme of what we're talking about here. But a lot of this does come back to the hardware. And you know as a software company we have limited ability to change that, but I think it's a very important point and one that's worth discussing.

MR. CONWAY: Thank you very much, Dr. Morgan. Emmy, I mentioned that I would come back to you. So, I have a question for you directly. I appreciate your participation and the participation of all the public hearing speakers today. Given the journey that you outlined as a patient, for those parents across the country that are listening and watching and for our other

folks that are across the country watching these proceedings, as you think of your own journey and you think of yourself at an early stage in that, when you look at virtual reality and augmented reality, what is the promise that you see to it and what is the challenge that you see to it for patients that might be starting a journey like yours or for parents who might be working with a young person? Thank you.

MX. SCHWAB: I appreciate the question and I think it does tie back to an earlier question. Look, virtual reality is exactly that, it's virtual. So, you could have the most cathartic, amazing, ecstatic experience that provides all of this insight in the moment but eventually you have to take the headset off. And if your real world not optimized for your care and your healing, anything in virtual reality is rendered meaningless in my opinion. You're talking about you know when you talk about underserved populations, if we're offering them care in virtual reality but they still have to worry about how they're going to pay their rent, how they're going to pay for food, if they're dealing with very serious substance use disorder, if they are being use by parents with very serious substance use disorder if there's you know intergenerational trauma, these are all the things that virtual reality in my opinion has some things to offer but the large scale problems that they have caused over history are things that need to be dealt with. I mean in this, in this -- you know and a lot of it has to do with the privatization of healthcare. I'm sorry to say but just on this panel alone the fact that we have an industry speaker and a patient representative that are both working at the same company that did receive federal grant money in 2018, that's -- for me that's a major ethical oversight and the fact that that was sort of allowed to occur does not really bode well because you're talking about care providers who are starting own businesses, you're talking about software development which relies on a dot of beta testing. How do you do that with patients? And

that's why I think you want to see more computational models that are actually seeing how the software would play out using AI before you offer it to any humans. But I would say that in order for virtual reality to be effective, the physical reality needs to be optimized, ameliorated. And I say like to anybody with -- or parents of someone who is going on a journey like me, I would say that the hardest part is to remove, in the case with my family, to have a bit of a sense of removal of one's self from the journey of your child to and to project your own sensibilities onto it and to listen to care providers. But it is a very tough question with a lot of considerations, a lot of institutional and legacy issues that I think need to be addressed in order to have any sort of productive conversation about the positive benefits of extended reality.

MR. CONWAY: Thank you very much, Emmy, for your candor. I appreciate it. Bennet, you will be asking the last question today.

MR. DUNLAP: Thanks. I'll try to be quick. This is specific and I'm sorry I didn't write down the name, but I think it got AC or OC Plus on the bottom of the slide. There was a conversation about using virtual reality where two patients were competing, and by the process of definition competing means there's going to be winners and losers and as someone that's been an official at youth athletics, that creates a whole lot of unhealthy dynamics and I was wondering what kind of protections were placed to make sure that there wasn't security lapses, harming the loser at the expense of the winner, that type of thing. It's a very quick question and I'm sorry I went on that long.

MR. CONWAY: No problem, Bennet. Is there somebody that you would like to direct that to, Bennet?

MR. DUNLAP: Unfortunately, I didn't get the name. I think it's got AC or OC plus.

DR. TAWFIK: AC plus, Accelerated Care Plus, John Tawfik here, representing this industry

company. An excellent question. Thank you, Mr. Dunlap, for that question. The software that we developed and that we use in geriatric rehab specifically addresses this point as compared to off-the-shelf gaming system that have been in the past used for similar purpose whether -- you know without mentioning any gaming devices, it actually provides for positive feedback even when there is a competition or cooperation in a multi-patient type of approach. So, messages like "you lost" or even "you won" are not displayed. Instead, positive feedback and positive affirmation is displayed to encourage both participants, whether those that have -- you know quote unquote have completed in a shorter amount of time or completed the puzzle more timely and effectively. They both would actually get positive results on the screen, and oftentimes may be using their own data as their baseline from which to compare future performance as well. So that's a way to be able to ensure that it is not a negative feedback and one that is discouraging to this person that may be underperforming. That's one aspect.

The other aspect is that the software is designed with a lot of parameter adjustments that would take in consideration varied level of performance of different patients. So, for example, you could perform a sit to stand repeated activity for geriatric patient. Someone who is able to complete that unaided without pushing off the chair. So, you would set the parameter so that for a patient to do a full sit to stand and then have a patient that is quote unquote competing or cooperating who is in a wheelchair have the same type of response from the software respond to forward leaning or pushing partially off the chair. So those variations would actually be parameter adjusted to allow for a meaningful camaraderie to be built into that exercise without discouraging those patients.

MR. DUNLAP: Thanks. I really encourage you when you answer something like that not to use the word "underperforming." Just ditch the word "under" and say "performing."

MR. CONWAY: Thank you very much, Bennet, for the question. And thank you, Mr. Tawfik. And I would like to thank all of our open public speakers for staying for the committee. As was outlined at the beginning of this by Dr. Shuren, the PEAC has operated in a manner that is fully embracing of the public. FDA has sought to gain patient insights and we've tried to deliver that consistently. And your ability to stay and invest your time is tremendously appreciated by each of the committee members.

This will conclude day one of this 2-day meeting of the PEAC. I would like to thank the committee and the FDA staff professionals for their contributions. I would also like to thank again the open public hearing speakers, industry, healthcare providers, patient advocates, patients and the FDA for their comments and their insight. The committee discussions will reconvene tomorrow and continue on July 13th, 2022, at 10:00 a.m. Eastern time. So, today's meeting of the Patient Engagement Advisory Committee is now formally adjourned. Thank you.

[End of meeting]