METAVERSE SAFETY WEEK

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MEDICAL XR & IMMERSIVE HEALTHCARE

IMMERSIVE HEALTHCARE & AI: FINDING THE BALANCE BETWEEN INNOVATION AND SHARED RESPONSIBILITY

DECEMBER 11, 2023
THE ROUNDTABLE REPORT

CO-ORGANIZED BY:

NHS England

MedXRSI

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AstraZeneca

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EXECUTIVE SUMMARY

The discourse surrounding the integration of Artificial Intelligence (AI) with healthcare has gained considerable attention this year across the ecosystem from regulators and innovators. However, there is a notable gap in addressing the intersection of AI in healthcare with immersive technology. The core of AI applications in healthcare relies on patient data, particularly protected data types, with Protected Health Information (PHI) defined in the US as information in medical records that can identify an individual and is created, used, or disclosed during healthcare services (General HIPAA Provisions (§160.103)). The definition of PHI established 27 years ago could not have foreseen the diverse array of data types emerging in the realm of AI and immersive technologies. Another consideration is that non-covered entities now effectively collect identifiable health information, necessitating extended protections for patient privacy beyond traditional healthcare norms and boundaries. Moreover, existing privacy regulations do not adequately account for the compounded sensitivity resulting from combining different data types, particularly in the context of AI-enabled digital immersive healthcare. **When these data are the foundation of AI-enabled digital immersive healthcare, a new set of standards and evaluation frameworks are needed to ensure fair and responsible use of patient data.**

Nuances and Challenges in AI-Enabled Immersive Healthcare:
In the evolving landscape of AI-enabled immersive healthcare, a key focus has been on understanding and addressing the complexities surrounding patient data types and the adequacy of existing privacy norms. The evolution of these data types, particularly in the context of immersive healthcare technologies, has outpaced traditional privacy frameworks like the HIPAA provisions, highlighting an urgent need for expanded privacy protections. This becomes especially pertinent when considering the sensitivity of combined data types in digital healthcare environments. Moreover, the implementation of AI in healthcare presents several critical challenges, including data acquisition, technology development, clinical factors, training and education, accountability and regulation, and the impact on human and social factors. Tackling these challenges effectively demands a collaborative and concerted effort from all stakeholders involved in healthcare, technology development, and

policy-making. This approach is crucial for harnessing the potential of AI in enhancing patient care while ensuring ethical standards and patient safety are rigorously maintained.

Principles for Ethical AI in Immersive Healthcare:

The Medical XR and Immersive Healthcare discussions emphasized essential recommendations for ethically implementing AI-enabled technologies in healthcare. Key among these is conducting thorough clinical trials to validate the efficacy of new technologies, ensuring they provide real benefits to patients. A significant focus was on human-centered and inclusive design, advocating for the development of accessible and beneficial AI systems for all users. The importance of creating responsible and trustworthy AI to maintain patient trust and safety was also highlighted. Equipping healthcare professionals with the knowledge and tools necessary to integrate these technologies into clinical practice is crucial, alongside fostering public understanding of AI's role in healthcare. Strict regulations and standards are essential for patient safety and care quality. Lastly, global collaboration is vital, allowing stakeholders to share insights and advance these technologies innovatively and ethically, prioritizing patient well-being.

Strategic Intelligence Gathering by MedXRSI and NHS:

The Medical XR and Immersive Healthcare track, coalesced by MedXRSI and the NHS, served as a critical forum for in-depth discussions among international stakeholders in the healthcare sector. This gathering aimed at dissecting the multifaceted challenges and opportunities presented by AI-enabled immersive healthcare. The focus was on developing strategies for integrating AI into healthcare in a way that enhances patient care and ensures safety. Key topics included the advancement of AI applications in clinical settings, the refinement of data management practices for patient information, and the exploration of new paradigms in the patient-clinician relationship. These discussions were pivotal in fostering a united approach towards the ethical integration of AI in healthcare, highlighting the necessity for varied insights in the development of AI-driven medical technologies. This initiative represented a significant step towards formulating holistic, patient-centric methodologies for the evolution of healthcare in the digital age.

The **Medical XR and Immersive Healthcare** track, a vital part of Metaverse Safety Week, brought together diverse experts to explore the transformative potential of AI-enabled immersive healthcare. The discussions focused on how this emergent technology can enhance healthcare practices, transform models of care, and streamline service delivery. This report captures the essence of these discussions, highlighting the collective commitment to leveraging AI in healthcare responsibly. The participants recognized the promise of new technology in improving healthcare but also stressed the need for caution to prevent any irreversible harms that could significantly impact patient quality of life and survival.

In this collaborative forum, stakeholders from various sectors pooled their knowledge and experience to chart a course for the responsible integration of AI in healthcare. The emphasis was on using AI to test novel ways of practicing medicine while steadfastly adhering to the principles of patient protection. The discussions underscored the importance of a careful approach to adopting these technologies, mindful of their potential to profoundly affect patient outcomes. The collective wisdom of the group was geared towards finding ways to harness the benefits of immersive healthcare technologies without compromising on patient safety and ethical standards. The roundtable aims for a future where medical practice is enhanced by AI, yet remains deeply rooted in patient-centric values.

Julia Scott
Exec Lead & Senior Advisor, MedXRSI
Chair - Medical XR and Immersive
Healthcare, MSW2023

Richard Price
Global Health Education
Technology Advisor, NHS England
Co-Chair - Medical XR and
Immersive Healthcare, MSW2023

INTRODUCTION

On **December 11, 2023**, a crucial roundtable on **Medical XR and Immersive Healthcare** convened, uniting diverse healthcare stakeholders from around the globe. Clinicians, innovators, researchers, and ethicists gathered to deliberate on the integration of AI and XR technologies in healthcare. This event marked a key step towards enhancing healthcare through these technologies, addressing the **challenges and potential of AI in applications, ranging from diagnostics to surgery.**

The roundtable highlighted the need for informed application and ethical considerations of AI, focusing on patient data management and the responsibilities linked to AI-driven decisions in healthcare. This gathering aimed to shape a future where AI and XR are seamlessly and ethically integrated into healthcare practices.

The participants discussed the necessity of integrating AI to enhance fundamental healthcare functions and enable scaling with minimal oversight. This convergence of AI with immersive healthcare applications, ranging from diagnostics to surgery, underscored the urgent need for debate and action, particularly before these technologies move beyond specialized care settings. This Medical XR and Immersive Healthcare roundtable signified a major advancement in the collaborative journey to revolutionize healthcare with AI and XR technologies.

KEY OBJECTIVES INCLUDED

- **Examine AI's role in immersive healthcare**, whereby new functionalities and streamlined care may improve patient outcomes.

- **Question AI's impact on patient-clinician relationships**, especially sustaining trust in both AI and clinicians.

- **Deliberate on how AI uses patient data**, in terms of informed consent and protected health information.

INTRODUCING SWARM AI

Metaverse Safety Week 2023 elevated the roundtable experience by integrating **Swarm AI®** technology from **Unanimous AI**. The innovative approach combined real-time human insights with AI algorithms, inspired by nature's swarm intelligence, to amplify collective decision-making. Participants engaged in a dynamic voting process, contributing to decisions that reflect a more profound collective wisdom for safeguarding the interests of AI and Emerging Technologies.

SWARM INTELLIGENCE
via UNANIMOUS AI

Swarm AI® technology, developed by Unanimous AI, employs a unique combination of real-time human input and AI algorithms that are modeled after swarms in nature. Swarm Intelligence is the reason why birds flock, bees swarm, and fish school – they are smarter together than alone. Nature shows us that by forming closed-loop systems, groups can produce insights that greatly exceed the abilities of any individual member. While humans have not evolved this ability naturally, Swarm AI technology enables this artificially, allowing groups to amplify their intelligence by forming real-time swarms.

THE ROUNDTABLE OVERVIEW:

On **December 11, 2023**, as a key component of the 2023 Metaverse Safety Week, a significant roundtable on **Medical XR** and **Immersive Healthcare** was convened. This event, organized to delve into the complexities of integrating AI and XR in healthcare, gathered leading experts from diverse healthcare fields. The primary objective was to explore how these emerging technologies could revolutionize patient care, diagnostics, treatment, and education in healthcare settings. Spanning three hours, the roundtable featured enriched discussions led by seasoned professionals, including clinicians, AI researchers, and policymakers, who shared their insights centering around the theme "**Immersive Healthcare & AI: Finding the balance between innovation, and shared responsibility.**" The roundtable was a critical forum for exchanging ideas and experiences aimed at advancing the safe and ethical integration of AI and XR into mainstream healthcare practices.

The hosts, Julia Scott and Richard Price were joined by the following individuals for the discussion. They both drove the discussion, with support from several XRSI Team Members and Advisors in the background.

The session commenced with insightful opening remarks from **Walter Greenleaf**, a distinguished behavioral neuroscientist and medical technology developer. Walter Greenleaf initiated the discussion by delving into the evolving landscape of healthcare, emphasizing the transformative potential of AI-powered immersive healthcare. He highlighted how these emergent technologies are crucially needed to meet global healthcare demands. Predicting a significant integration of these technologies into healthcare infrastructure over the next 15 years, Dr. Greenleaf underscored the importance of understanding the historical context and decades of research that have laid the groundwork for today's digital health revolution. His opening address set a foundation for the ensuing discussions that focused on how AI and immersive technologies are poised to reshape healthcare delivery and patient care.
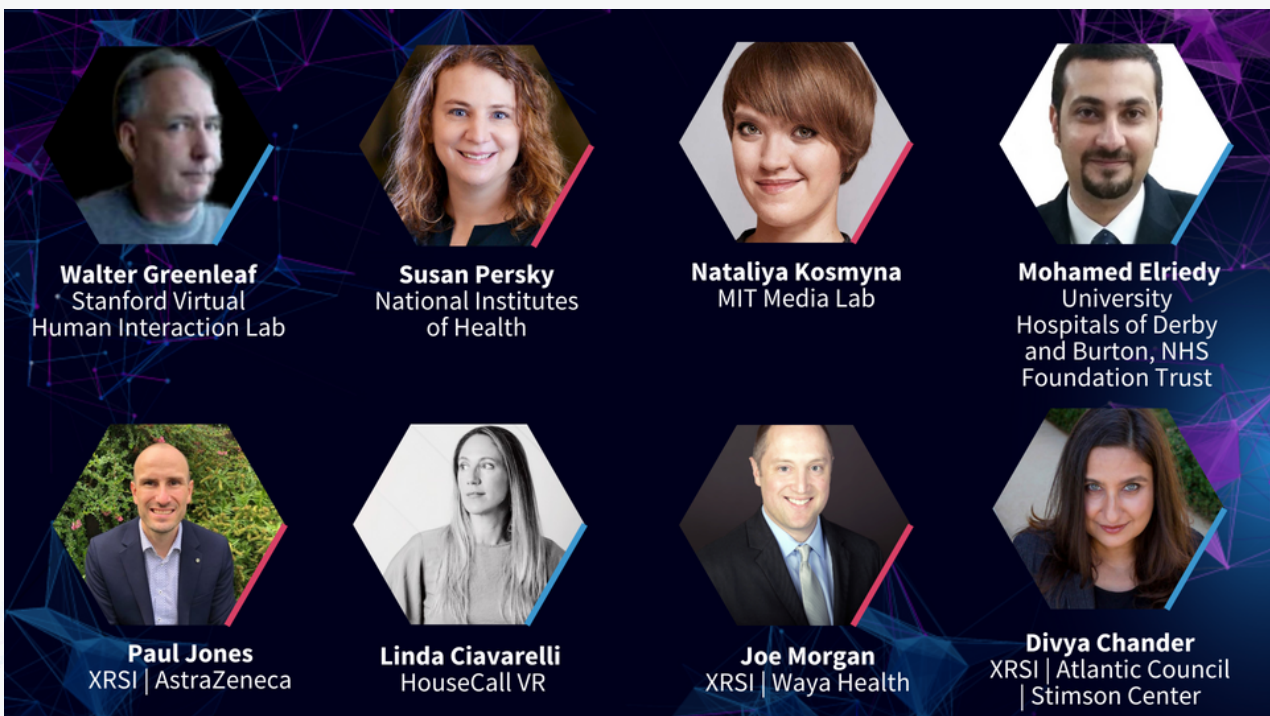
"We're seeing the movement of the digital twin paradigm that's being used in managing factories and cities into the healthcare arena. With this movement that captures a digital twin of ourselves, we are concerned about protecting that information."

- Walter Greenleaf, Neuroscientist

The following distinguished panelists brought forth their knowledge and explored actionable strategies and collaborative initiatives to ensure that AI and XR in healthcare prioritize patient safety, dignity, and the highest ethical standards in this advancing field.

Walter Greenleaf
Stanford Virtual Human Interaction Lab

Susan Persky
National Institutes of Health

Nataliya Kosmyna
MIT Media Lab

Mohamed Elriedy
University Hospitals of Derby and Burton, NHS Foundation Trust

Paul Jones
XRSI | AstraZeneca

Linda Ciavarelli
HouseCall VR

Joe Morgan
XRSI | Waya Health

Divya Chander
XRSI | Atlantic Council | Stimson Center

Contributing Roundtable Members not pictured: Brendon Hale (SB Group, LLC), Andreas Forsland (Cognixion), Jordan Wiseman (XRSI), Payal Ghatnekar (NHS), Jean-Simon Fortin (Paperplane Therapeutics), Ryan Cameron (XRSI), Peter Oykman (PsyTech), Asher Marks (Yale),

Susan Persky, leading the Immersive Simulation Program at NIH, emphasized the need for rigorous evidence in applying immersive technologies in medicine. She focused on the importance of thorough evaluations to ascertain the real benefits and risks, especially in the context of XR and AI-integrated applications. Persky advocated for high-quality trials with valid comparators and reliable data practices, discussing XR's diverse potential in healthcare. Her insights offered a critical framework for assessing XR's efficacy and risk-benefit balance, essential for its effective integration into healthcare interventions.

> *"We can think about XR more sort of a pill or a capsule that might control the dispersal of a drug over time. It's important for the treatment, but it isn't necessarily by itself the intervention."*
>
> **- Susan Persky, National Institutes of Health**

Mohammed Elriedy, from Queen's Hospital Simulation Centre, brought a blend of medical expertise and technological enthusiasm to the roundtable. With a focus on immersive technology and AI in medical education, he outlined the NHS's application of these tools in various domains, including patient care, staff well-being, and physiotherapy. Elriedy stressed the importance of safety, diversity, and inclusivity in technology integration. He highlighted key questions around public trust, ethical use, and collaboration, emphasizing the need for careful, informed advancement in healthcare technology. His insights pointed to the delicate balance between leveraging technology's potential and maintaining ethical and quality standards in healthcare.

Dr. Joe Morgan, founder of Waya Health and an anesthesiologist, concluded the discussion by highlighting the integration of generative AI into patient-facing XR applications for pain management. His expertise in both medicine and technology development informed his discussion on the promise of XR in healthcare. Morgan emphasized XR's role in enhancing patient care and addressing provider burnout, focusing on the importance of safety, privacy, and care enablement in these applications. His insights revealed the transformative potential of XR in healthcare, underscoring the need for thoughtful and ethical technology integration to empower both patients and healthcare providers.

Dr. Divya Chander underscored the necessity of building privacy systems from inception in patient-immersive healthcare setups. She highlighted the importance of prudent data collection and advocated granting patients the right to revoke collected data. Dr. Chander delved into strategies for robust data protection, AI transparency in patient communication, and the evolving landscape of biometric data collection in wearables and immersive environments. The discussion also covered disparities in data labeling and security, ownership of generated data, and stakeholder roles in protecting and utilizing data. Additionally, it touched on challenges around informed consent for patients unable to provide it and intriguingly explored the potential trust patients might place in their avatars over healthcare providers within these immersive healthcare contexts.

Paul Jones raised concerns about reward-based economies potentially posing significant societal and data-related challenges. He highlighted the dual nature of use cases inpatient arenas, acknowledging equal risks and rewards. Jones emphasized the need for accountability within hardware and software systems while advocating for informed awareness of tools within cloud enterprises, prompting discussions on delineating clear accountability lines for structured data trajectories.

Engagement of all participants throughout the meeting was achieved with AI-powered polling using Swarm AI on key questions. By adopting this technology, the roundtable harnessed the amplified intelligence of its participants, facilitating a more nuanced and comprehensive exploration of the topics at hand. These inquiries pressed the group on challenging issues on these themes that sparked deeper discussion.

The issues discussed include the challenge of keeping the vast amount of data collected private and safe, the changing role of clinicians within this augmented ecosystem, difficulties with interoperability, and building trust and managing realistic expectations of the use of these technologies.

KEY MESSAGES FROM THE DISCUSSION:

- The role of a clinician is changing as clinician duties move closer to informatics with the introduction of power tools through AI, machine learning, and immersive systems.

- While immersive technologies will be important for the treatment, XR will most likely never be the intervention and should be viewed as the enabling technology for a specific treatment.

- Initiatives like the digital twin paradigm for healthcare requires the collection of a large volume of very personal information. Keeping this information secure and respecting patient privacy is a challenge that is not met by current infrastructure and policies.

- The diversity of immersive applications means that sufficiently testing XR and AI technologies to ensure fitness for the demands of each intended healthcare domain will require special considerations for the various factors that influence the their use.

- As AI-enabled immersive applications are deployed at scale, healthcare systems must be aware of barriers to access for populations in order to ensure equitable distribution and minimize potential discriminatory practices.

- Open-minded collaboration and experience sharing are indispensable in the effort to establish a safe and respectful development ecosystem over full product lifecycles.

THEMATIC SESSION 1: INFLUENCE OF AI AND IMMERSIVE TECHNOLOGY ON PROVIDER-PATIENT RELATIONSHIPS

With AI and immersive technologies becoming increasingly ubiquitous in the healthcare ecosystem, it is imperative that we consider its implications on patient and provider experiences. This roundtable session engaged experts in both healthcare and technology sectors to discuss the perceived benefits and harms associated with XR, the metaverse, and AI in healthcare ecosystems. The key objective here was to reflect on the changing dynamics in patient-provider relationships, and the potential impact these emerging technologies could have on the trust and bonds nurtured with patients.

Dr. Linda Ciavarelli set the stage for the thematic discussion by highlighting the critical role of AI-enabled VR in patient education through her work at HouseCall VR. She focused on developing immersive content to educate patients about their medical conditions and treatments. Dr. Ciavarelli underlined the transformative impact of VR in patient education, a field ripe for innovation. She emphasized the need for collaboration in the ethical use of these technologies, stressing their potential to enhance provider-patient relationships while addressing safety and ethical challenges.

"Data is really a shared responsibility between technology companies, between patients, between hospital systems. The whole health care system as a whole needs to come together and to actively work together to leverage this amazing technology in a responsible way."

- Dr. Linda Ciavarelli, HouseCall VR

Overall, there was a shared recognition of both the excitement around the transformative potential of both XR and AI in healthcare as well as the apprehension around concerns related to privacy, data security, and the ethical considerations surrounding these technologies.

The conversation highlighted the complex and multifaceted nature of these issues and underscored the need for extensive collaboration across the whole healthcare ecosystem. Collective or shared responsibility between patients, providers, and technologists was seen as indispensable to navigating these challenges effectively.

Protecting patient privacy and data security was raised as one of the key issues surrounding AI-driven or immersive healthcare. While establishing frameworks and contemporary policies that align with the evolving landscape of digital health was deemed extremely crucial, participants acknowledged that this would be no easy feat. Challenges of defining the boundaries of ownership and accountability, in particular, emphasized the need for regulatory bodies to craft stringent protocols and appropriate policies. The conversation also extended to the necessity of fostering a culture where organizations developing XR and AI applications for healthcare embed privacy and security considerations into their process from the onset. Participants also pointed out that there is an opportunity to learn from existing frameworks like the shared responsibility models designed for cloud services and discussed decentralized approaches, like federated learning, that could potentially alleviate some of the complexities with respect to data security.

Throughout the discussion, participants also stressed that building trust with both patients and providers hinges on transparency. Within this context, specific concerns were raised about plausible hesitancy among healthcare professionals that should be remedied through appropriate education and training for healthcare staff to build trust and foster the safe adoption of AI and immersive technologies. When it comes to transparency, a systems-thinking approach that recognizes the various stakeholders, processes, and components across the entire healthcare ecosystems was advocated for. This includes entities ranging from hardware manufacturers and content creators to patients and caregivers. Lastly, participants stressed on the importance of holding space for open reflective discussions, much like this roundtable, where multidisciplinary perspectives can be brought together to highlight challenges and illuminate possible solutions.

THEMATIC SESSION 2:
DATA PRIVACY AND PATIENT AGENCY IN AI-ENHANCED IMMERSIVE HEALTHCARE

The expanding range of sensitive health information in immersive contexts and the subsequent use of this data as fuel for AI models can both benefit and exploit patients. There is, therefore, a need to establish what the balance between maintaining data privacy and empowering patient agency over this data could look like. This discussion in this roundtable focused on the role of informed consent, which depends on educating patients and consumers about data collection, and the ownership of their healthcare data. Ensuring consent and privacy guidelines are ascribed to requires engaging various stakeholders in securing sensitive health information. The importance of understanding how new monitoring technologies change the risk landscape was underscored as being crucial to our ability to safeguard patients and providers in both healthcare and consumer applications.

In this thematic discussion, **Dr. Nataliya Kos'myna**, Director of the Fluid Interfaces Lab, highlighted the vulnerabilities of IoT devices, immersive technology, and biosensors in protecting user data and maintaining personal autonomy. She emphasized the need for proactive regulation in these rapidly evolving fields, underlining the importance of safeguarding against potential breaches and unethical uses. Dr. Kos'myna's focus was on the intersection of technology and privacy, stressing the impact these advancements could have on personal autonomy and the critical need for effective frameworks to ensure data security and ethical application in healthcare.

"This is what I want to encourage from the research perspective…. You know reactivity is not going to help you. It's really more about being proactive in safety by design."

- Dr. Nataliya Kos'myna, Fluid Interfaces Lab, MIT

One key aspect highlighted was the shift from the traditional clinic-based recordings with trained healthcare providers to data collected through consumer wearables and implantables. Participants were especially concerned about the possible lack of user awareness regarding the collection of their health, biometric, and biometrically inferred data with AI and XR applications in the consumer space. There was an acknowledgement that people might be more inclined to share their data if they see value in it that could benefit themselves or others. However, this only emphasized **the need to evaluate and carefully balance potential benefits against individual rights.** The conversation also touched upon the distinction between informed consent and end user license agreements that are primarily designed to protect companies and providers. This drew attention to the need for user-friendly and comprehensible informed consent processes as well as thoughtful considerations for situations when patients might be unable to provide consent.

The balance between technology innovation and safeguarding healthcare ecosystems may appear in conflict. However, the conversation emphasized the **importance of co-designing with users as a way to foster innovation and increase organizations' likelihood of success** which symbiotically respects of patient and caregiver values. This approach involves creating solutions with users, rather than merely for them, and should pay special attention to reaching underserved populations. It should also extend the focus beyond solely considering the cost of care and patient outcomes and include considerations for provider experiences and the fulfillment healthcare professionals derive from their work.

Another area of focus was **the need for increased education and awareness about existing standards in the field**, suggesting that completely rewriting rules may not be necessary. Emphasis should also be placed on understanding effective encryption and algorithmic methods, like securing data at the edge, and having these approaches integrated at the early design and development stages. There was also a call for regulatory bodies to invest in infrastructure and provide resources (like development tools, plugins, and usable templates) to practitioners working with emerging technologies, like AI and XR, and encourage alignment with industry values and standards.

STRATEGIC INTELLIGENCE GATHERING SESSION VIA SWARM AI

In the thematic sessions focused on finding the balance between innovation, and shared responsibility, the innovative Swarm AI® technology developed by Unanimous AI played a crucial role. Key unresolved issues about AI in healthcare were raised, focusing on system preparedness, data management, and patient-clinician relationships. The discussions reflected a collective commitment to a patient-centric approach in adopting AI technologies in healthcare.

Question for deliberation: Which is the greatest risk to patient data in AI applications?

Response: Misrepresentation and inaccuracies

The discussion around this question highlighted the nuances, considerations and complexities inherent in considering different factors when it comes to AI in healthcare. When asked about the greatest risk to patient data in AI applications, the group agreed that misrepresentations and inaccuracies posed the greatest harm that would impact care plans in all their forms (Fig -1). This ranked above risks to privacy, ambiguity in data ownership and consent, bias in model decision-making, and meaning of AI-derived health data.
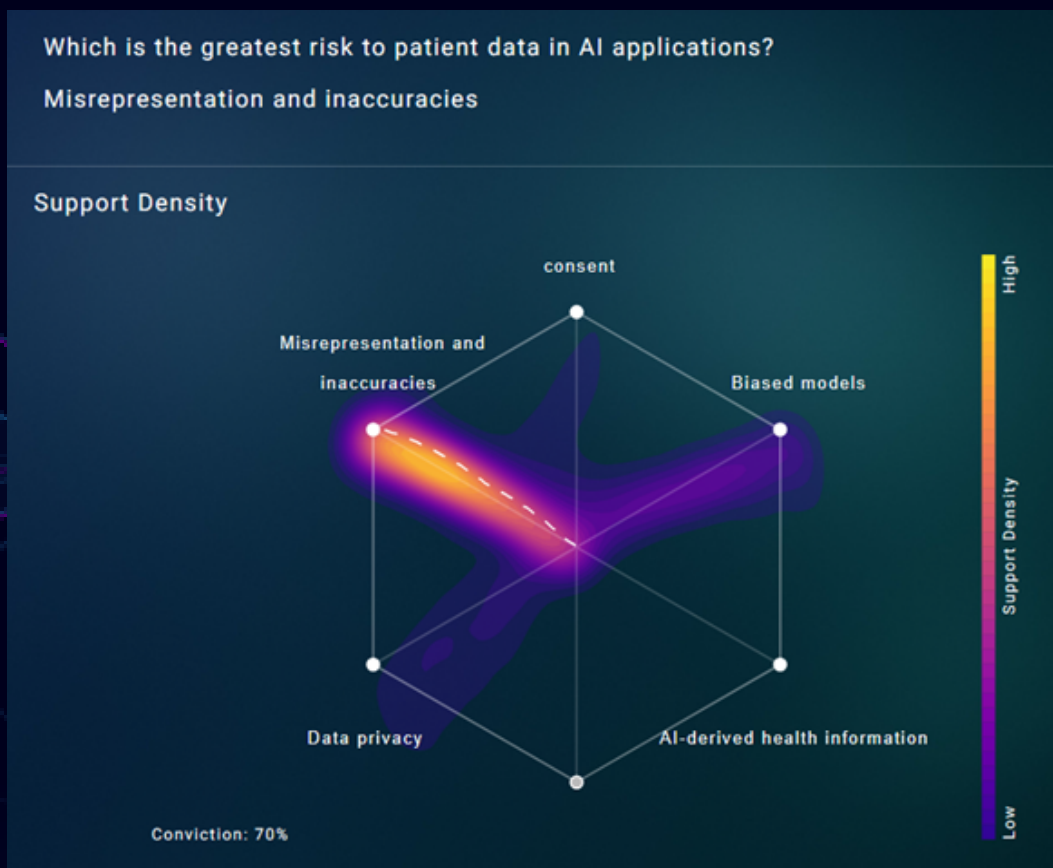

FIG -1

Question for deliberation: Starting with LEAST, what is the GREATEST concern regarding AI impact on this relationship?
Response: Detailed explanation below (Multi-stage question, no single answer)

This question reflected on how the use of AI influenced the relationship between patients and providers. Consistent with the previous discussion, participants grappled with the challenging decision between prioritizing privacy and accuracy in healthcare. While acknowledging the difficulty of the choice, the consensus leaned toward preferring an accurate diagnosis, especially because clinicians have a personal responsibility associated with it and the consequences of an inaccurate decision was viewed as a more significant concern than potential breaches of information privacy (Fig - 2 & 3). The final ranking of concerns from least to greatest follows:

- Bond with AI
- Bedside manner
- How a decision was made by AI
- Responsibility for decision-making
- Breach of privacy
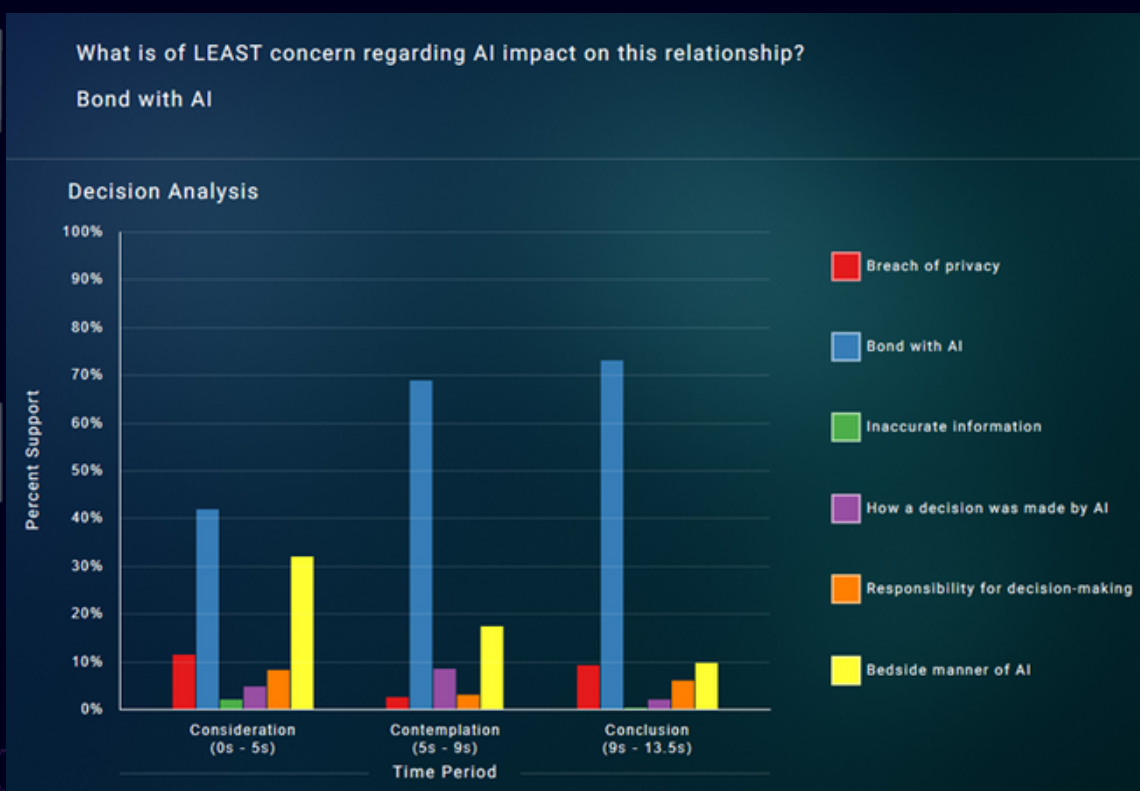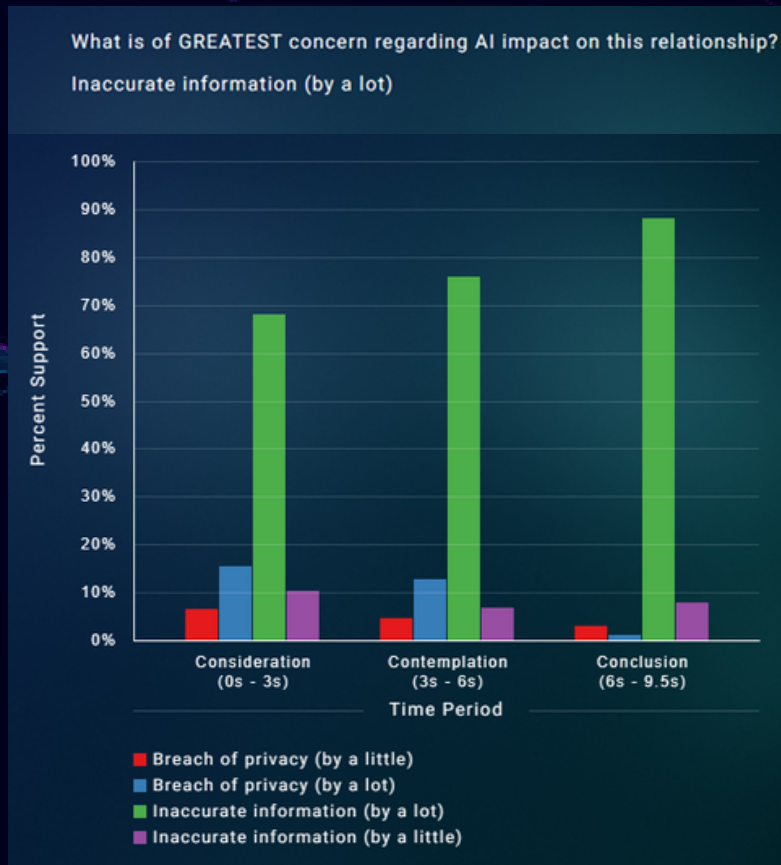- Inaccurate information

FIG -2

FIG -3

Utilizing Swarm AI, the roundtable harnessed a rich array of expert insights, fostering a collaborative and comprehensive understanding. This method proved vital in developing strategies and recommendations tailored to the unique demands of healthcare in AI and XR domains. Our approach emphasized innovation, efficacy, and inclusivity, ensuring that our outcomes effectively tackle the complex challenges of patient safety, data privacy, and ethical considerations in immersive healthcare environments.

"So I think there's not only data agency, but then there's value of [patient] data to other individuals or how it can be used to benefit other organizations.... Now, the question really is how do we create the opportunity to pass that through to our clinicians and share that data with our clinicians so that I maintain my data agency if I'm the person sharing it. "

- Brendon Hale, SB Group LLC

KEY CHALLENGES TO SAFEGUARDING HEALTHCARE

The future of healthcare relies on mitigating potential risks and challenges introduced by AI and immersive technologies. Here we delve into specific challenges across six key areas (Fig - 4) as identified by the roundtable discussion and extended by the Medical XR advisory council, shedding light on critical aspects that demand focused attention and strategic solutions.

1. Data Acquisitions

- **Complexity of consent and privacy breaches:** In healthcare data acquisition, particularly with AI and XR technologies, the complexity of informed consent and the risk of privacy breaches are major challenges. Obtaining consent is complex due to patients' need to understand the implications of their data being used in advanced technologies. This task is made more difficult by the dynamic nature of these technologies, which can evolve beyond the scope of initial consent. Additionally, the vast amount of sensitive health data collected heightens the risk of privacy breaches. Such breaches not only violate patient privacy, but also undermine trust in healthcare systems, potentially deterring patients from utilizing beneficial technologies.

- **Lack of reliable healthcare datasets:** Accessing and collecting appropriate and relevant data can be challenging in healthcare settings, making it difficult to create reliable datasets for healthcare applications. Inaccurate or incomplete datasets also pose a significant risk when using AI-based methods. Inaccurate data can stem from various sources, including sensor errors, improper data entry, or limitations in technology capturing comprehendive health information. Incomplete data often arises from gaps in data collection methodologies or selective data reporting, leading to biased algorithms and skewed outcomes. These gaps can result in misdiagnosis, ineffective treatment plans, and potentially harmful clinical decisions.

- **Disparate sources and data explosion:** Combining data from disparate sources, such as electronic health records, laboratory systems, medical imaging, and wearable sensors requires sophisticated integration processes. While the benefits of successful integration are substantial, considering the varied standards across systems and ensuring that the data is reliable, accurate, and up-to-date can be a daunting task. This is further exacerbated by the data explosion immersive technologies and generative AI models will bring, where the sheer volume and rapid generation of digital health information could be quite challenging to manage with current methodologies.
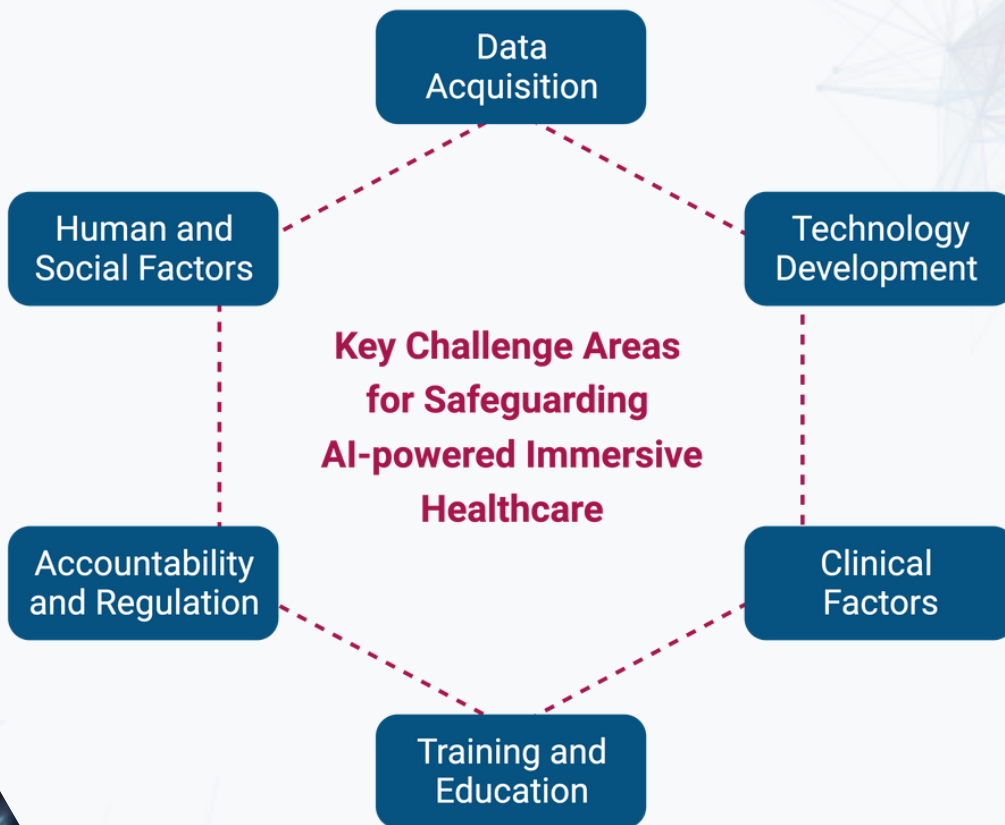

FIG -4

2. Technology Development

- **Ensuring meaningful use of data and preventing misuse:** Meaningful use involves harnessing collected health data to enhance patient outcomes, improve diagnostic accuracy, and tailor treatments effectively. However, there's a fine line between beneficial use and misuse, which can manifest as unauthorized access, sale of sensitive data, or use for purposes other than intended healthcare improvements. Such misuse can lead to privacy breaches, loss of patient trust, and skewed medical research.

- **Accounting for data bias:** Biased data stemming from non-diverse datasets that fail to adequately represent the full spectrum of patient demographics lead to biased AI models. Unchecked biases in models targeted for use in healthcare settings can result in misdiagnoses, unequal treatment, and ineffective medical interventions. This risk is particularly high for underrepresented groups. Accounting for the shortcomings of the data available and counteracting the biases require an intricate understanding of the influence of a myriad of factors including socioeconomic status, gender, age, race, geographical location, and other cultural nuances. However, this is an especially tall ask given the multifaceted variables in healthcare as well as the historical biases embedded in today's systems. Moreover, the dynamic nature of healthcare means that biases can evolve over time, necessitating ongoing monitoring and adjustment.

- **Technical complexities and financial constraints:** XR and AI-driven systems tend to be computationally expensive and require scalable and high-performance computing infrastructures and state-of-the-art hardware, especially for applications that demand robust real-time processing. In addition to the technological constraints, integrating these systems will also necessitate a substantial upfront financial investment that could further strain healthcare budgets. This challenge could be particularly pronounced for smaller and more rural healthcare facilities, potentially threatening equitable access to these technologies.

3. Clinical Factors

- **Conducting clinical trials and determining treatment efficacy:** Conducting reliable clinical trials and determining treatment efficacy in the context of AI and XR technologies in healthcare presents unique challenges. These trials must navigate the complexities of integrating advanced technologies into diverse clinical settings to ensure that they accurately reflect real-world conditions. Another significant hurdle is ensuring the validity and reliability of the results, as patient interactions with AI and XR applications can vary and are influenced by a multitude of factors. Additionally, the rapid evolution of technology we are witnessing can outpace the traditional pace of clinical trials, threatening the relevance of these trials by the time they conclude.

- **Inadequate strategies for misdiagnosis, malfunction, and emergency response:** Misdiagnoses due to immersive or AI-driven systems and malfunctions in these technologies - whether due to interface failures, algorithmic errors, hardware failures, or integration issues - can disrupt patient care and compromise safety. The uncertainties with detecting these technology-induced errors and the lack of robust emergency response protocols for these failures further exacerbates these risks.

- **Disruption of existing clinical practices:** Traditional workflows and treatment protocols may be significantly altered as these emerging technologies introduce new methods for diagnosis, decision-making, patient interaction, and treatment. Furthermore, there may be a learning curve associated with adopting new technologies, requiring additional training and adaptation time. Despite the potential for improved patient outcomes and enhanced treatment options, this disruption could lead to initial resistance from those accustomed to conventional practices. The transition to the ubiquitous use of AI and XR in healthcare could therefore cause a temporary decline in the efficiency and effectiveness of clinical practices.

- **Over or under-dependence on technology:** Achieving a balanced approach where technology is leveraged for tasks that benefit from it while preserving human judgment for complex-decision making can be challenging. Over-dependence on technological interventions can diminish the impact of human expertise and intuition, create a false sense of security, and undermine a holistic approach to patient care. On the other hand, under-dependence or hesitancy to fully integrate these technologies could result in missed opportunities for enhanced diagnostic accuracy, treatment efficiency, and patient reach.

4. Training and Education

- **Technology literacy and competency training for providers:** As AI and XR become more prevalent in diagnostics, treatment planning, and patient management, ensuring that healthcare providers are well-equipped with the necessary skills and knowledge becomes paramount for the safe, ethical, and effective use of these advanced technologies in patient care. The lack of adequate literacy and competency training for healthcare professionals could lead to misinterpretation of AI-generated data, over-reliance on technology, or underutilization due to a lack of trust or understanding.

"I think once you add technology to [patient data], it's just super charges that capacity to acquire more data.... But you have to make sure that if you collect it that it will be useful and that it's done in a way that you can collect it safely. And if you need to share it, it still has to undergo that privacy and respect, whatever the patient consented to.... You know, it has to be within those boundaries."

- Jean-Simon Fortin, Paperplane Therapeutics

- **Lack of awareness among patients:** Patients often lack the necessary knowledge to understand and effectively engage with new technologies and understand its implications on their health, leading to confusion, fear, and distrust. Therefore, without proper information and education, patients may not be able to fully benefit from the potential advantages these technologies offer, potentially hindering their wider adoption. However, diverse levels of digital literacy among patients along with the unique considerations required for different applications would make it hard to create a one-size-fits-all solution.

- **Continuous and evolving educational needs:** The rapid evolution of AI and XR technologies and their dynamic lifecycle can make it challenging to maintain adequate education for both patients and providers. Integrating continuous training for healthcare professionals to stay updated on the latest advancements and modifications will be challenging, and keeping patients consistently informed about the latest technological developments could be overwhelming and hinder patient engagement. Needless to mention, developing and maintaining these resources will require substantial effort that might be difficult to scale and sustain.

- **Managing public perceptions and expectations:** Public perceptions are often mixed, ranging from unrealistic expectations about the capabilities of these technologies to undue skepticism and fear of new interventions. These perceptions are influenced by various factors including personal and cultural experiences, media portrayal, and general knowledge about AI and XR. Effectively managing these perceptions requires transparent communication across all levels of society. However, different stakeholders may have varying interests and priorities, adding an extra layer of difficulty to achieve required alignment.

5. Accountability and Regulation

- **Ambiguity with data ownership and management:** Patients need assurance that their sensitive health information is treated with the utmost care and respect for their values. However, as health data becomes increasingly digitized and integrated into advanced technologies, determining who owns and controls this data - whether it's the patient, healthcare provider, or technology developers - becomes a critical concern as determining the rights and responsibilities of each stakeholder can be a complex problem. This ambiguity in data ownership can lead to ethical and legal dilemmas, especially when it comes to sharing, selling, or using patient and provider data for research and clinical purposes.

- **Regulatory gaps and a lack of standardization:** The evolution of emerging technologies and their deployment in healthcare settings are outpacing the development of corresponding regulations and standardized protocols. However, the absence of uniform standards and the resulting inconsistencies in technology development pose substantial challenges to interoperability, quality control, patient safety, and treatment efficacies. The lack of actionable guidelines also hinders the seamless integration of AI and XR into existing healthcare infrastructures.

- **Difficulties with cross boundary data sharing:** Concerns about patient privacy and data security are amplified when data crosses boundaries and jurisdictions with differing standards and levels of protection. The complexity of ensuring compliance with different data laws and ethical regulations could make the seamless exchange of health data across borders challenging. These disparities could introduce operational hurdles that delay global health initiatives, potential innovation, and collaborative research.

6. Human and Social Factors

- **Ensuring accessibility, equity, and cultural sensitivity:** Designing technologies that cater to a wide variety of populations and do not exacerbate existing health disparities is key to bridge healthcare gaps in ways that do not exacerbate existing health disparities. However, the task becomes particularly complex due to the myriad interconnected factors that influence healthcare disparities. Economic status, geographical location, language barriers, and cultural differences collectively shape the accessibility and acceptance of AI and XR solutions making it especially challenging to build uniform scalable systems.

- **Difficulty building trust in immersive and AI-enabled systems:** Public hesitation towards these technologies often stem from concerns about privacy, data security, and the impersonal nature of care it might encourage. Misconceptions and a lack of understanding about how AI algorithms make decisions can exacerbate these concerns, leading to reluctance in adopting these technologies. For healthcare professionals, trust issues revolve around the accuracy and reliability of AI recommendations, which can sometimes seem opaque or counterintuitive. This is compounded by worries about AI replacing human judgment and expertise, potentially leading to misdiagnoses or inappropriate treatment plans.

- **Impact on provider-patient relationships:** While these technologies can enhance diagnostic accuracy and treatment efficiency, they may also introduce a level of impersonality into the healthcare experience. Patients accustomed to traditional face-to-face interactions might find immersive or AI-driven consultations less empathetic or engaging, potentially affecting their satisfaction and trust in the healthcare system. On the provider side, reliance on AI for diagnostic and treatment recommendations could reduce their perceived value of clinical expertise, potentially leading to a sense of professional detachment and lower engagement with patients.

RECOMMENDATIONS FOR STRATEGIC EFFORT

Here we recommend key strategic efforts and research through which we can navigate the integration of AI and XR technologies into healthcare ecosystems with resilience and efficiency, ultimately enhancing patient outcomes and healthcare delivery (Fig - 5).

- **Validate the expected value through clinical trials**

  - **Moving beyond preliminary studies towards more extensive randomized controlled trials** is imperative to establish a robust foundation for the value proposition of these emerging technologies in healthcare. This rigorous evidence generation demands reasonable comparators and careful consideration of endpoints measured in valid ways. It is also important for trials to be continuously extended to larger populations to ensure it represents the diverse populations that these technologies aim to serve.

  - **Establishing standard frameworks for clinical trial design** that are specifically focused on XR and AI will help outline and tackle the additional parameters these technologies bring that may not be considered in conventional clinical trials in a systematic manner.[1] Guidelines to create adaptive trial designs that allow for the flexibility required to handle rapid technological evolution and the uncertainty that comes with AI models is also critical to maintaining the trials' validity over time.

  - **Virtual trials incorporating digital health twins or agent simulations offer a pathway towards preliminary explorations** of potential benefits of an application, allowing us to prioritize and allocate resources towards clinical trials that have a higher probability of bringing real value to human life without overburdening patient and participant populations.

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- **Prioritize human-centered and inclusive design**

  - **A vigilant commitment to human-centered practices and thoughtful design** is vital to ensure that systems that utilize these emerging AI and XR technologies not only meet technological objectives, but also align harmoniously with the needs and experiences of patients, providers, and other diverse stakeholders involved in the ecosystem.

  - **A balanced approach that emphasizes collaboration between technology and humans** is needed, where the technology built complements human expertise without replacing it. This entails recognizing the unique strengths each brings to the table and designing technology to serve as a supporting tool that augments the capabilities of human professionals. Such an approach intrinsically maximizes the benefits of innovation while keeping human judgment, intuition, and empathy at the forefront of development strategies.

  - **Cultural sensitivity should be embedded in the design process**, ensuring respect for varied healthcare practices and patient expectations. Collaboration with community leaders, patient advocates, and cultural experts is key to enhancing the appropriateness of these technologies while ensuring they enhance care practices without widening disparities. Immersing technology researchers and practitioners in healthcare settings and co-designing possible solutions with patients and providers will illuminate real-world pain points, foster creativity, and ensure the integration of XR and AI into healthcare ecosystems are contextually impactful and relevant.

VALIDATE THE EXPECTED VALUE OF AI AND XR	• Conduct extensive randomized control trials • Establish standard frameworks and guidelines for trial design • Incorporate virtual trials for preliminary explorations
PRIORITIZE HUMAN-CENTERED AND INCLUSIVE DESIGN	• Commit to human-centered practices and align with stakeholder needs • Build technologies that complement and augment human expertise • Respect varied practices and embed cultural sensitivity in the design process
DEVELOP RESPONSIBLE AND TRUSTWORTHY TECHNOLOGIES	• Implement robust safeguards to protect user privacy and data integrity • Design systems to provide users with agency over their healthcare journey • Develop and rigorously test interfaces that cater to diverse abilities
EMPOWER PROFESSIONALS AND ADAPT CLINICAL PRACTICES	• Provide education support to ensure sufficient technology proficiency • Develop comprehensive frameworks that outline appropriate use of technology • Create contingency plans and alternative pathways in case of malfunction
FACILITATE INFORMED DECISION MAKING AND PUBLIC LITERACY	• Develop transparent and easy to understand consent forms • Empower patients to make informed decisions through customized resources • Adopt a multifaceted approach through public education campaigns
ESTABLISH STRINGENT REGULATIONS AND STANDARDS	• Develop legal frameworks and regulations for governing data management • Establish stringent policies for regular audits and monitoring systems • Introduce measures and financial support to assist smaller facilities
FOSTER COLLABORATION TOWARDS GLOBAL ADVANCEMENT	• Foster the exchange of insights among healthcare centers and diverse regions • Encourage research collaboration efforts to pool expertise • Advance globally beneficial healthcare technology with diplomatic initiatives

FIG -5

- **Develop inherently responsible and trustworthy technologies**

  - Implementing robust safeguards to protect user privacy and data integrity is key to developing inherently responsible and trustworthy technologies. This includes the development of robust algorithmic security measures and stringent access controls that would serve as a critical line of defense against various privacy and security concerns. Meticulous consideration of data ownership, responsibility, and protection from the earliest stages of development is crucial to reinforce the trustworthiness and reliability of immersive and AI-powered healthcare solutions.

○ **Designing systems that provide users with agency and control over their healthcare journey** by prioritizing transparency and solutions that allow patients and providers to understand the functionality and decision-making processes behind the immersive and AI-powered systems. Such systems help build user trust, foster a sense of empowerment, and remain resilient to evolving perceptions about these emerging technologies.

○ **Developing and rigorously testing interfaces that cater to diverse abilities** like varying levels of tech literacy, physical abilities, and language proficiencies is crucial and ensures that patients of all backgrounds can effectively interact with and benefit from AI and XR technologies. Iterative and continuous engagement with key stakeholders will help establish feedback loops to refine XR and AI interfaces throughout its lifecycle.

• **Empower healthcare professionals and adapt clinical practices**

○ **Robust education and training support for healthcare professionals that ensures sufficient technology proficiency** is key to the seamless integration of AI and XR technologies into clinical processes. Effective training strategies should ensure providers understand the underlying principles, potential biases, and limitations of these technologies. They should also emphasize hands-on experience and reliably test provider skill levels before they are certified to use new technological interventions. Continuous development opportunities and platforms for collaboration among professionals can also support ongoing learning and the knowledge exchange required to deal with the constantly evolving landscape of immersive and AI-based healthcare. Public-private partnerships and industry collaborations could reduce the collective burden of resource development and make continuous education more feasible.

- The development of comprehensive frameworks that outline the appropriate use of technology and the creation of contingency plans is critical for quick and effective interventions in case of malfunctions or emergencies. This includes clear guidelines for healthcare professionals to identify, flag, and rectify technology-induced errors. It also includes the creation of alternative diagnostic and treatment pathways to ensure uninterrupted patient care.

- **Facilitate informed decision-making and public understanding**

  - Developing transparent and easily understandable consent forms that educate patients about the potential uses and evolution of their data in advanced technologies like AI and XR is pivotal in retaining and supporting patient agency. This also includes accounting for situations where the patient cannot provide explicit content, confirming secondary applications of patient data are aligned with values, and ensuring patients are informed about any changes in data usage.

  - Empower patients to make informed decisions about their healthcare through customized educational resources that cater to diverse levels of digital literacy and comfort. This should include both the unique considerations of each application or intervention as well as general education about their rights and standards set by organizations and regulatory bodies. Transparent communication about the realistic capabilities and limitations of AI and XR in healthcare is essential to support patient agency.

> *"We don't necessarily have to rewrite the rule book per se. But we have to at least have a heightened level of education awareness of what's already been done so that we can conform to certain standards for safety and efficacy."*
>
> — Andreas Forsland, Cognixion

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○ **Adopting a multifaceted approach through public education campaigns** can demystify these technologies and lay the groundwork for general literacy that minimizes information overload for patients when they enter the healthcare system. This approach involves transparent and widespread communication from healthcare institutions, technology developers, and governments. Engaging with the media for accurate portrayals and utilizing social platforms for education can further enhance public understanding. Special efforts should be made to build trust, dispel myths, and align expectations with the actual benefits and risks associated with these emerging technologies.

• **Establish stringent regulations and standards**

○ **Developing clear legal frameworks and robust regulations for governing data ownership and management** are the key to protecting patients' rights, promoting responsible data use, and clarifying stakeholders' roles and responsibilities in the data lifecycle. This includes prioritizing the curation of diverse datasets, standardized interoperability, and data validation protocols to ensure that data can be collected, shared, and understood uniformly and reliably. Regular updates to these regulations and global standards are critical to keep up with technological advancement.

○ **Stringent policies for regular audits and monitoring systems** also need to be in place to detect and prevent misuse, accompanied by severe consequences for breaches. This requires the development of valid quality control measures that are designed to identify and rectify inaccuracies and failures efficiently.

- ○ **Policy measures and financial support mechanisms should be implemented to assist smaller and rural healthcare facilities** in acquiring and integrating XR and AI-driven systems. This could involve government subsidies, technology provider partnerships, and shared infrastructure models. Prioritizing cost-effectiveness and scalability in the development and deployment of these technologies will contribute to their wider adoption and equitable distribution across diverse healthcare settings.

- **Foster collaboration towards global advancements**

  - ○ **Encouraging collaborative endeavors and fostering the exchange of insights** among healthcare centers and diverse regions facilitates mutual learning and the establishment of harmonized global norms and agreements. Research collaboration, specifically, plays a key role in pooling expertise and resources to advance medical knowledge and innovation collectively.

  - ○ **Diplomatic initiatives between countries and international organizations** can help expand the reach of our collective healthcare expertise. Special focus on ethical considerations and cultural differences could help standardize data-sharing protocols and facilitate the seamless exchange of health data across borders. These efforts could set the foundation for the advancement of globally beneficial healthcare technology.[4]

CONCLUSION

The Medical XR and Immersive Healthcare roundtable for the 2023 Metaverse Safety Week stretched a range of possibilities, inquiries, and unmet challenges in the field. The contributors dove deep into two key areas of XR and AI in healthcare: the relationships between everyone working across the healthcare ecosystem and ways to protect data privacy and patient agency in AI-enabled immersive healthcare. This was the start of the conversation that will be followed by collaboration amongst stakeholders to build trust, agency, and equity.

The opportunities held by AI-enabled immersive healthcare can improve patient care and elevate provider abilities. To meet this promise, a strong foundation in the digital capability of care systems and patient literacy in data privacy and technology is first required. As these solutions and systems are built, equity in access to the technology, not just in upper-income countries but across global health systems, must be part of the design and supported development. Within these systems, patient data must be used responsibly to create a virtuous cycle of trust between clinicians and the technology and between patients and the technology. These responsibilities include minimizing the bias of models based on demographics and using data that are equitable to ensure fair delivery of care.

The shared responsibility model described in the recommendations sounds idealistic and will be challenging to design and implement in any care system, yet it is the most robust way to ensure patient's rights. Inevitable compromises by stakeholder groups will be necessary to achieve this goal. However, principles of equity in care access and patient agency must be preserved. Our data is a powerful component of the AI and immersive technologies that are emerging in healthcare. When biodata, spatial data, and behavioral data are input to deep learning and transformer models and drive immersive experiences, new therapies, diagnostic tools, and assistive technologies are possible. Setting up safeguards from the point of design onward will enable their realization.

The patient experience of care is further transformed by the personalization and accessibility generative AI provides. AI-enabled 3D visualizations and digital twins will change how providers perceive and process patient records. These technologies can bridge the collaboration of providers across continents through connected devices that enhance the capacity and ability of medical care globally. **Technology mediated interactions between patients and providers, as well as between clinicians, simultaneously opens up new opportunities and vulnerabilities.**

Developing innovative solutions discussed in this roundtable will require cooperation from all stakeholders – developers, clinicians, policymakers, and researchers. Further, ensuring equity and in delivery and safety by design will require accountability by ethicists, regulators, and payers.

The insights and questions unearthed at Metaverse Safety Week may be used to guide strategic plans at organizations within the healthcare system, from industry to regulation. The contributors hope this report, including the related references, may inform and challenge readers in their role in immersive healthcare, data privacy, and patient safety.

CALL TO ACTION : ADOPT MSW

Since its inception in 2020, Metaverse Safety Week (MSW) has illuminated the intricate fusion of Immersive and emerging technologies. MSW 2023, in particular, highlighted the symbiotic relationship between AI and these environments, unveiling their immense potential alongside inherent risks. As the Founder and CEO of XRSI, I urge stakeholders to <u>adopt MSW as an annual awareness campaign</u>, galvanizing action to shape a secure future for the Metaverse.

- ## The Imperative for 2023 and Beyond
  MSW 2023 emphasized the urgency to safeguard the Metaverse, calling for action beyond risk acknowledgments. It's about actively shaping a secure future within this evolving landscape.

- ## Empowering through Education
  Engage with us and partake in a wide range of activities aimed at raising awareness, educating stakeholders, and promoting a safer and healthier Metaverse for global citizens. Prioritize educating teams about this evolving landscape, issuing transparency reports, and making commitments to drive collective action.

- ## Shared Responsibility, Collective Action
  Join us in adopting MSW as a yearly initiative to fortify alliances, develop best practices, and craft protective policies for these immersive landscapes. It's a shared responsibility across individuals, organizations, policymakers, and creators to ensure a secure Metaverse.

This isn't just a campaign; it's a commitment — a shared responsibility to safeguard the future of the Metaverse. Whether you're a government, a big technology organization, a creator, an educator, or a policymaker, your role is pivotal in promoting a culture of safety and trust within these emerging realities.

> *"Let's unite in this endeavor to fortify our shared vision of a secure and transformative Metaverse. **I implore you to join hands and hearts in adopting the Metaverse Safety Week (MSW) campaign by signing the MSW charter** and standing with us as we shape a future that's safe, ethical, and full of boundless possibilities."*
>
> **- Kavya Pearlman, Founder & CEO - XRSI**

CO-ORGANIZER DETAILS

ABOUT MEDXRSI

XRSI's Medical XR Advisory Council (MedXRSI) brings together thought leaders, healthcare experts, and visionaries to identify business opportunities and help develop innovative and trustworthy content for doctors, researchers, and healthcare professionals. The purpose of this collaboration is to establish a basis upon which to foster and improve the safety of the medical XR ecosystem from cybersecurity and privacy threats.

The Council is committed to building the strategies and resources necessary to help healthcare solution providers, healthcare delivery organizations, and regulatory organizations leverage XR to be more successful. The council also collaborates with agencies like the FDA, NHS WHO, CDC, and other industry advisory councils to further study the positive as well as the undesirable consequences of XR adoption within the medical ecosystems.

Our Key Principles:

1. Patient Safety First
2. Protect Patient Data
3. Healthcare for All

CO-ORGANIZER DETAILS

ABOUT NHS ENGLAND

NHS England is the executive non-departmental public body of the Department of Health and Social Care that oversees the budget, planning, delivery, and day-to-day operation of the commissioning side of the National Health Service in England as set out in the Health and Social Care Act 2012. As the steward of England's healthcare budget, NHS England is committed to ensuring that healthcare resources are used efficiently and effectively to meet the diverse needs of the population. From primary care to specialized treatments, our scope of services is vast, addressing the health requirements of individuals at every stage of life.

We lead the way in healthcare innovation, investing in research and the latest technologies to enhance patient care. Our efforts extend beyond treatment to preventive care, with initiatives focused on public health and education to promote healthier lifestyles. Guided by the principles of universality, accessibility, and excellence, NHS England is dedicated to the ongoing improvement of healthcare services.

APPENDIX 1: SUGGESTED READINGS

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7. X Reality Safety Intelligence (XRSI). Human Rights in the Age of Neurotechnology: Impact, Opportunities & Measures. (2023). XRSI. https://xrsi.org/publication/human-rights-in-the-age-of-neurotechnology-impact-opportunities-measures

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APPENDIX 2: OUTPUT FROM SWARM AI SESSIONS

Question & Answer	Conviction
How prepared are healthcare systems for the changes in data and AI? **Answer: 0%**	**49%**
Which is the greatest risk to patient data in AI applications? **Answer: Misrepresentation and inaccuracies**	**70%**
Who should be responsible for managing patient data generated by AI? **Answer: Healthcare system**	**73%**
How should consent for data use in AI applications be obtained? **Answer: Per item opt-in by patient**	**79%**
How important is it to know how AI decisions are made? **Answer: Very important**	**62%**
What is of GREATEST concern regarding AI impact on this relationship? **Answer: Inaccurate information (by a lot)**	**81%**
What is of LEAST concern regarding AI impact on this relationship? **Answer: Responsibility for decision-making**	**67%**
What is of LEAST concern regarding AI impact on this relationship? **Answer: How a decision was made by AI**	**62%**
What is of LEAST concern regarding AI impact on this relationship? **Answer: Bedside manner of AI**	**81%**
What is of LEAST concern regarding AI impact on this relationship? **Answer: Bond with AI**	**69%**

1. AI-guided decision making transparency and explainability

Question for deliberation: How important is it to know how AI decisions are made?
Response: Very important

The group was asked their opinion on the importance of understanding how AI-powered clinical decision support tools and interventions. Everyone agreed it was important to understand to some degree, yet also acknowledged that effective and accurate AI is not always explainable by its very nature. AI is doing work that humans either do not do well, human logic cannot perceive, or humans do not fast enough. What was prioritized more was efficacy, performance and safety. The principle applied here is analogous to the norms of the medical field to not fully understand how pharmaceutical medicines work, yet still accept them as safe and effective treatments. The common goal amongst the group was to improve patient care and quality of life (Fig -6).
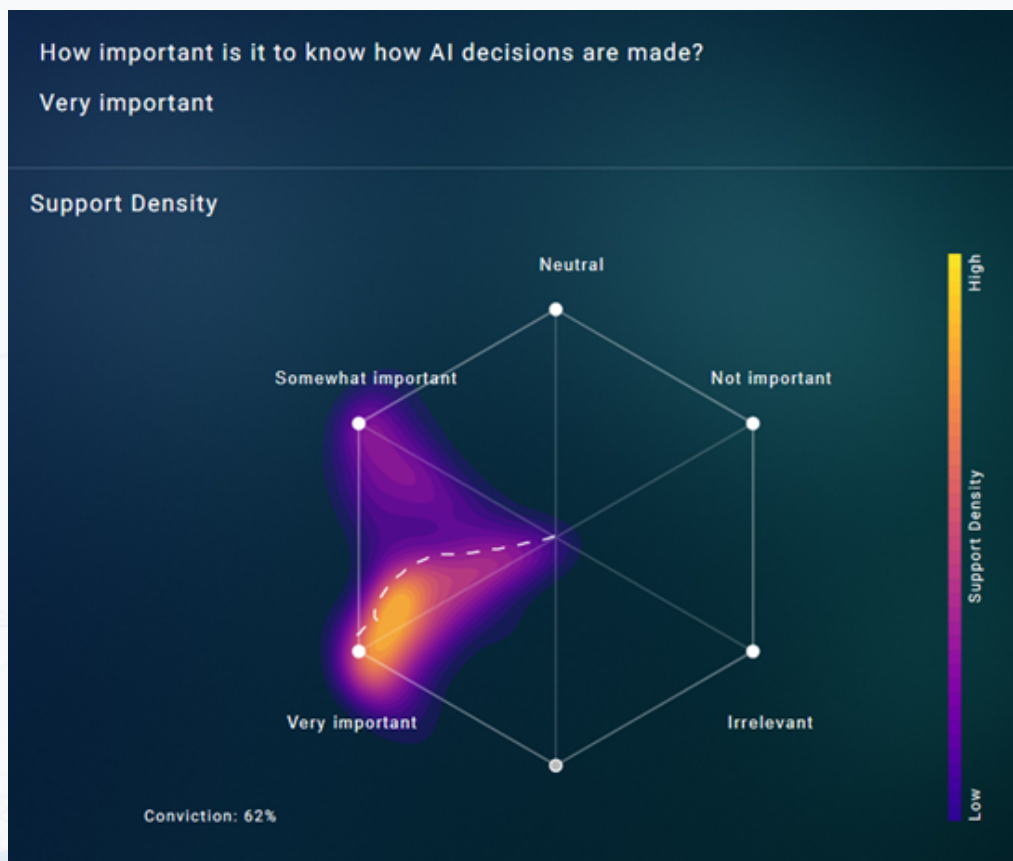
FIG -6

2. Methods of informed consent for AI applications

Question for deliberation: How should consent for data use in AI applications be obtained?
Response: Per item opt-in by patient

A rich discussion around the issues of consent highlighted the many factors that might make it challenging to have overarching guidelines. Participants were asked whether the patient or provider caused typical consent for AI applications, default opt-in or opt-out, and whether consent could be selective for types of data usage. One highlighted aspect was that underserved populations and minorities may have varying levels of trust in governance or healthcare systems due to historical factors. Additionally, while it would be preferred to have an option-in approach if patients have the cognitive ability to express their intentions, having an overly granular approach where they need to individually opt-in to every AI-based care or decision-making would negatively impact trust and hinder their ability to get proper care. This indicates that the context and circumstances of the patient play a crucial role in determining the appropriate consent model in healthcare involving AI technologies. The discussion expressed concern over the "digital exhaust" of the vast amounts of data being generated and left behind, underscoring the need for careful management and ethical considerations in handling such sensitive information (Fig - 7).
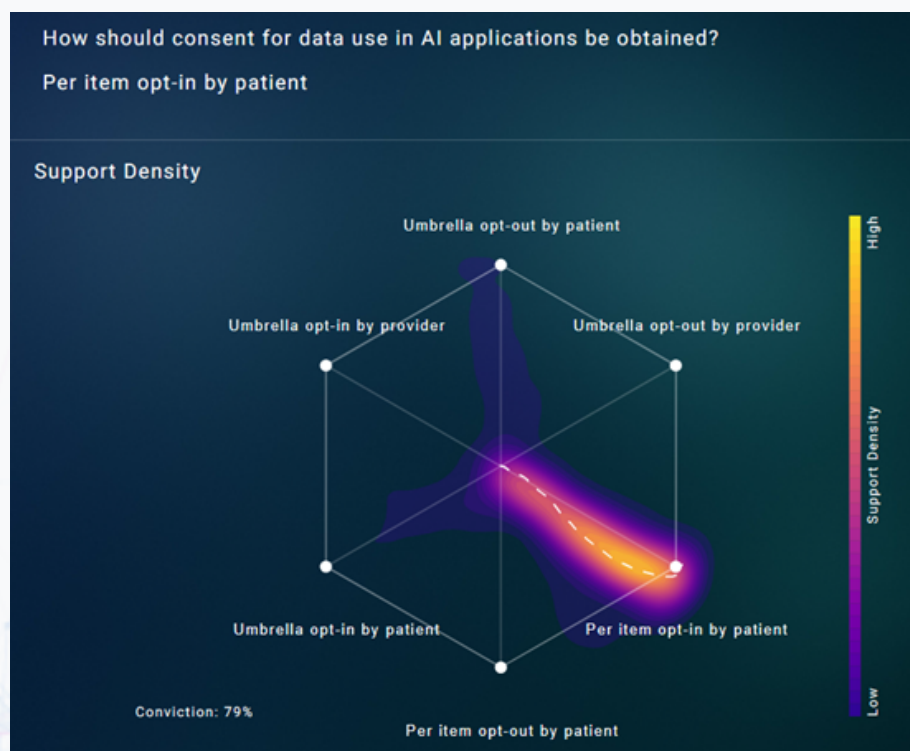

FIG -7

3. Responsibility for patient data and associated preparedness of healthcare systems

Question for deliberation: How prepared are healthcare systems for the changes in data and AI?
Response: 0%

Participants were asked to assess how prepared healthcare systems are for the change in data and AI on a scale of 0 to 100%. Responses wavered between 0 and 25%, with a slight favor of nearly no readiness for the incoming quantity and complexity of data that is inherent to immersive technology and AI. However, when asked who is most responsible for managing AI-derived patient data, the group pointed to the healthcare system with strong conviction over vendors, clinicians, and patients. Readiness of a healthcare system is dependent on the AI literacy of providers and staff, IT infrastructure for storage, security, and management of data, integration with electronic health records, and the funding to support such services. The mismatch in assumed responsibility and actual state of healthcare systems globally highlights the extent of work required before AI-enabled immersive technologies are deployed to serve patients at large (Fig - 8).
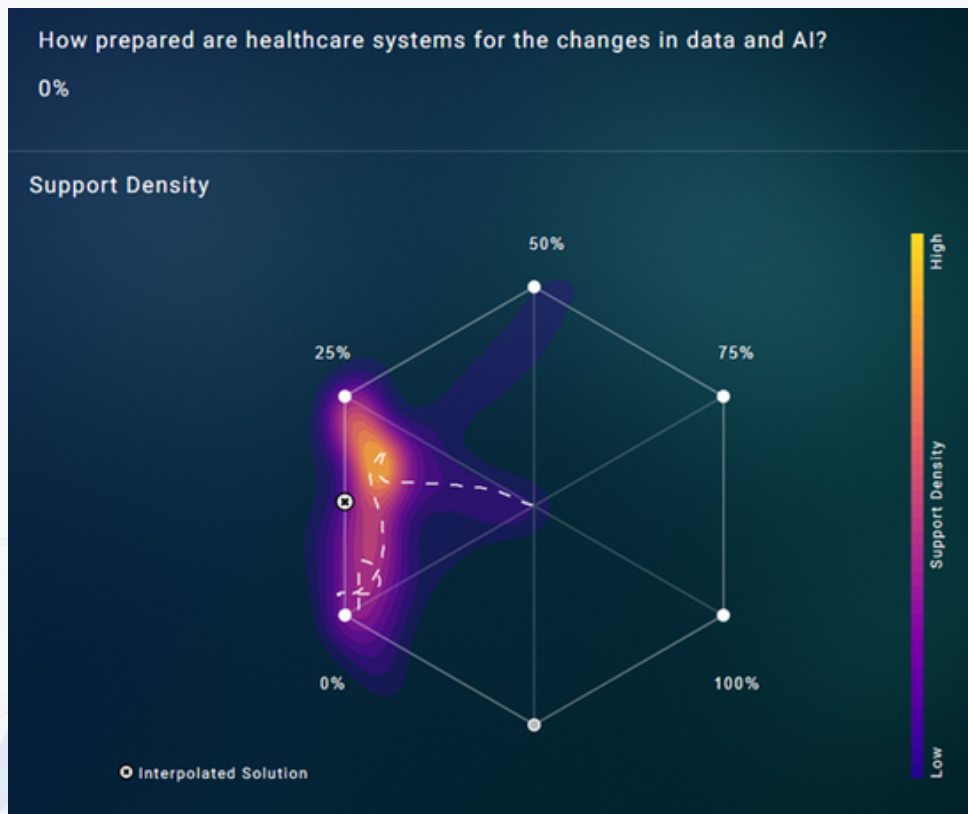

How prepared are healthcare systems for the changes in data and AI?

0%

Support Density

50%

25%   75%

High

Support Density

0%   100%

Low

○ Interpolated Solution

FIG - 8

MEDICAL XR AND IMMERSIVE HEALTHCARE

LEAD AUTHORS

Janet Johnson
XRSI | University of Michigan

Julia Scott
Exec Lead & Senior Advisor, MedXRSI
Chair - Medical XR and Immersive Healthcare, MSW2023

PROGRAMMING COMMITTEE MEMBERS: MEDICAL XR AND IMMERSIVE HEALTHCARE

Julia A Scott
XRSI | Santa Clara University

Richard Price
NHS England | XRSI

Kavya Pearlman
X Reality Safety Intelligence (XRSI)

Paul Jones
AstraZeneca | XRSI

Divya Chander
XRSI | Atlantic Council, Stimson Center

Ryan Cameron
XRSI | Electric Puppets Inc

Jared Kutzin
Icahn School of Medicine at Mount Sinai | XRSI

Oliver D'adda
XRehab | XRSI

Joe Morgan
Waya Health | XRSI

Janet Johnson
XRSI | University of Michigan

Catherine Subhashini
Yale University | XRSI

Payal Loma Ghatnekar
NHS England | XRSI

Bhanujeet Choudhary
X Reality Safety Intelligence (XRSI)

Michael Iwashima
Santa Clara University

Akshat Kalra
Santa Clara University
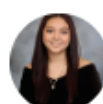
Andrea Mendoza
Student at The Wharton School

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Jean-Simon Fortin
Paperplane Therapeutics

Elena Mercep
XRSI

Janet Johnson
XRSI | University of Michigan

Michael Iwashima
Santa Clara University

Ryan Cameron
XRSI | Electric Puppets inc

James Doty
Stanford University

Jared Kutzin
XRSI | Icahn School of Medicine
at Mount Sinai

Payal Ghatnekar
XRSI | Torbay and South
Devon NHS Foundation Trust

Jonathan Morris
Mayo Clinic

Jonathan Wakim
Penn Medicine

Akshat Kalra
Brain and Memory Care Lab, SCU

Rolf Illenberger
VRdirect

Tatum Hunter
The Washington Post

Lloyd Harding
Healthy Mind VR

Paul Jones
XRSI | AstraZeneca

Asher Marks
Yale Center for Immersive
Technologies in Pediatrics

Charles Binkley
XRSI | Hackensack Meridian
Health

Brendon Hale
SB Group LLC

Divya Chander
XRSI | Atlantic Council |
Stimson Center

Dorothee Caminiti Markkula
Center for Applied Ethics -
Santa Clara University

Elsa Papadopoulou
Bioinformatics and Human
Electrophysiology Laboratory
(BiHELab), Department of
Informatics, Ionian University

Peter Oykhman
PsyTechVR

Catherine J

Arjun Puri
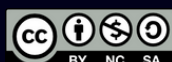
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