



REAL HEALTH - HOW XR IS TRANSFORMING HEALTHCARE

Abstract

Extended Reality (XR), also referred to as immersive technologies covers Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR). There is a growing need for all Healthcare players to adopt innovative solutions to accelerate digital transformation to meet the rising customer expectations and improving access to care. The pandemic has shifted gears to leverage new age technologies to navigate the customer journeys.

XR is revolutionizing Healthcare Industry by providing more value and generating more impact to customers. Metaverse combined with XR, AR, VR, IoMT, cloud, Quantum computing and robotics provide a lot of scope for transformation in Healthcare Industry.

Metaverse offers endless possibilities in healthcare to address some of the key challenges to improve access to care and quality of care. Healthcare Organizations can integrate into Metaverse Virtual Environments built on XR to provide customized Patient experiences.

Introduction

Healthcare industry is witnessing a lot of changes with emerging trends like patient consumerization, personalization of care, Virtual care, more agile and resilient supply chain, automation, and revenue management, etc. Healthcare players are adapting to these changes to stay competitive in the market.

Healthcare has been going through digital transformation and is being disrupted with cutting edge technologies to provide more personalized care to patients. Organizations are continuously on the look out to introduce new ways to improve quality of care for better Business outcomes. They are investing heavily in research and development in all areas of healthcare like Preventive care to In-hospital care and post treatment care. Providers and payers are using immersive technologies to provide personalized care as per the convenience of their patients with human like interactions virtually from anywhere in the world.

Modern Healthcare players are exploring new opportunities with XR (VR, AR, MR) to provide a promising future. XR holds a lot of potential to assist medical practitioners in collaborating with other stakeholders and participating in critical decision making in life saving scenarios. The Global AR/VR in Healthcare market is estimated to be worth \$9.79 Billion by 2027.¹

Need for continuous innovation in healthcare

Healthcare Industry is changing rapidly and constantly responding to the evolving digital imperatives. As we move to experiential age, with shifting priorities of consumers, it has become even more important to explore emerging technologies to improve the patient experiences and health outcomes.

Consumers are demanding easier, convenient, and personalized options in every aspect of healthcare. With the connected digital world, consumers are used to speed and accuracy in all the transactions in all aspects of life and healthcare is no exception. The pandemic has further accelerated digital transformation in healthcare from virtual care to Home and Hybrid care reaching consumer where they are and delivering healthcare services as per their convenience. The Healthcare industry is evolving with innovative solutions such as digital supply chains, interoperability, fast and ease of access to integrated health records and collaboration tools for providers in healthcare centers to drug discovery and development, decentralized clinical trials options, etc. Industry is being disrupted with technology players entering healthcare sector with innovations that are constantly extending the boundaries of health services.



Patients: Consumerism is on the rise across all industries. Healthcare is also turning more patient-centric as the expectations of consumers are changing drastically in all aspects of healthcare,- like purchasing insurance, patient education, receiving care, post care treatment, etc.



Provider: Providers are compelled to offer more promising options to gain the trust of patients with accurate diagnosis and treatment options with an intent to provide better health outcomes

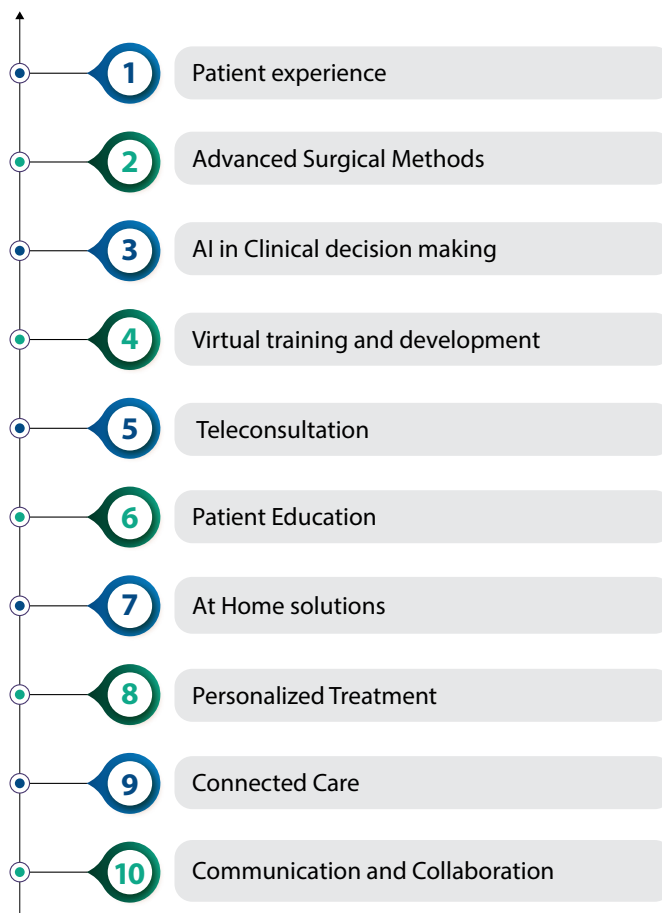


Tech Industry: Technology industry is introducing many newer technologies to address many healthcare challenges with IoT, AI, ML, Data Analytics, XR, etc.



Payer: Payers are focusing more on value-based care which can be enabled by building whole patient data (Behavioral and Physical health data) on a common platform and exchanging data across the eco system for better diagnosis and treatment and to generate insights for more personalized options and thereby control overall cost of care

Key areas of Innovation



Emergence of XR in Healthcare

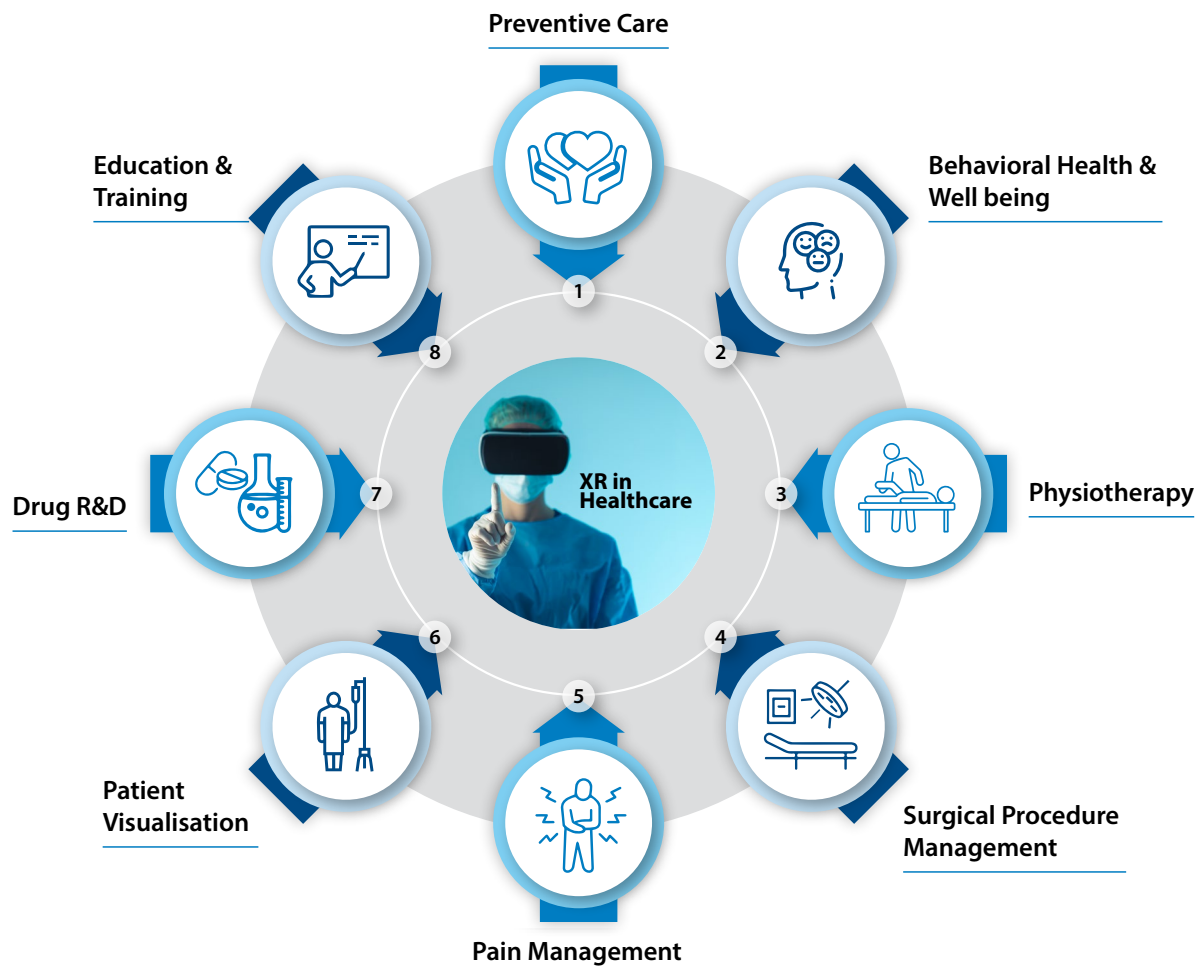
XR is changing the way we learn, operate, interact, collaborate, consume and provide services. With the growing need for improving quality of care and value-based care, emerging technologies like XR are proving to be an exciting area of innovation and present a lot of opportunities for transforming healthcare. XR is poised to become a part of daily life for users across the globe. XR is going to be the next logical step in the development and usage of Human Computer Interface. It can achieve psychological presence for patients and can be used to enhance empathy and humanistic skills for healthcare staff and to improve surgical performance

Various hues of Reality

- **XR- Extended Reality:** A umbrella term for immersive technologies such as Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) by simulating physical environments. MR, AR, VR
- **Virtual Reality (VR):** Virtual Reality is a simulated environment that is created exactly like real environment and presented to the user in such a way that the user believes and accepts it to be real
- **Augmented Reality (AR):** Augmented reality is a highly visual and interactive method of presenting digital information on top of physical environment in real time
- **Mixed Reality (MR):** MR brings the Digital and real-world elements together by super imposing digital objects on real environment. It is beyond the Augmented reality wherein we can even manipulate the digital objects

Let us examine some key business areas in healthcare where XR can play a vital role in meeting the needs and objectives of payers, patients, providers and other healthcare staff

XR in Key areas of Healthcare



Preventive Care

Immersive technologies can engage patients easily and encourage them to exercise and simulate the progress of health by sticking to various wellness plans. Applications can gamify the experience to maintain routines, control their emotional stress and talk to virtual or automated agents and provide real human like interactions.

We can build a platform to improve physical and mental health to have a holistic digital health solution.

Guided Wellness Routines

XR applications can be built with personalized daily routines with planned physical exercises like yoga, posture correction, sequence of guided steps, tracking personal health goals and incentivizing proper and regular workout. They can help to motivate to move and continue to keep trying to beat our personal scores

Simulation

Meditation: The virtual environments with best places in the world can be simulated for peaceful and soothing experiences to bring calmness to mind and help relax.

Avatar: Simulating the health scenario with the immersiveness of XR can bring in empathy by being in the shoes of a person with medical condition to help take preventive actions and take personal care seriously. XR can help reflect a person in the form of avatar depicting the consequences of avoiding the necessary care plans

Provata Health launched a virtual reality (VR) guided meditation application. It is a fully immersive virtual reality meditation application with which, users escape to a variety of stunning locations around the world, including tropical waterfalls, secluded beaches, dazzling Northern Lights and even underwater coral reefs. Selecting from a collection of guided meditation exercises, users train their mind to positively impact their productivity and mood in immersive, idyllic setting²





Behavioral health and well being

XR can be a vital tool for improving behavioral health. It can be used for therapeutic intervention by simulating the real-world mental health scenarios to detect the symptoms early. Stress disorders, phobias, depression and anxiety problems can be addressed using applications. Technology companies are designing games in health with immersive experience using XR, which can drive motivation and influence the behavioral patterns of patients. The industry is anticipating huge growth and diversity in games for health which has been accelerated with Covid in the past couple of years. For example, NHS, UK has begun using XR technologies in mental health.

Various user experiences in mental health settings can be built using XR to improve overall health. Various organizations across the world can collaborate and work together to help the patients virtually. It can also play significant role in reducing loneliness.

Health Assessment

Health assessment of patients with present condition, basic physical health, mental health based on history and behavioral patterns can be done to determine a personalized care plan. Various conditions like stress management, sleep patterns, etc. can be studied and assessed.

Detection & Diagnosis

Immersive technologies can be brought together with 3D Models to spot the issue and detect patient's illness. Certain tumors, bone fractures, swelling of nerves, etc. can be detected with XR applications and can be shown to patients also while providing consultation.

Therapeutic Intervention

Mind is the medicine. Digital Therapeutics can be used to provide drug-free, personalized therapies at the comfort of home in multiple mental health scenarios. It can be used for fitness tracking. Therapeutic game therapies can address certain psychological issues like stress and depression through structured gaming scenarios. By adding intense and playful gaming sequences to flip the mind and move the body, patient mood can be assessed and influenced. Therapeutic games are now being designed to be used in clinical settings as well.

While the adoption has a long way to go in other medical communities, in US, some VR-based therapies have FDA approval but are mostly combined with cognitive behavioral therapy and physical therapies.

MyndVR at Home has been specially built for ease-of-use and simplicity, making it a snap for seniors and caregivers alike to be up-and-running with VR in minutes. With MyndVR at Home, seniors and their caregivers can enhance their relationships by experiencing virtual reality adventures together – using the companion tablet paired with the VR headset³

Physiotherapy

Therapy Recommendation

XR applications can be used for remote physical therapy. Patients would be guided through motions and exercises through the display as well as by a remotely located human therapist who also helps with pain management

Rehabilitation

With engaging XR therapies, patients can reach their therapy goals faster. They enhance patient experiences while expediting the recovery and help patients work on rehabilitation right from their bedside. Patients would be challenged to come up with therapeutic tasks that also apply to patients' daily life.

Neuro Rehab VR is an XR Therapy System, a clinically validated and FDA registered virtual reality (VR) therapy system for neurological rehabilitation and physical therapy treatment and assessment in clinical environments. It has been developed to allow outpatient physical therapy centers and hospitals to work on patient physical therapy for upper and lower extremity, cognitive therapy, pain and anxiety alleviation, behavioral and social skills training, and more, through a library of VR applications.⁴

Surgical Procedure Management

XR technologies can help in preparation and during the surgery for an effective planning and execution of the surgeries.

Preparation

- ▶ Patients waiting for long hours in the preparation waiting anxiously for their surgery can be engaged to escape from the confines of physical spaces to interact with nature or be in breathtaking environments to calm their senses and relieve stress.
- ▶ Providers can use this technology to conduct surgery simulations going through 3D replicas based on patient scans and can further use them to collaborate with their team and come up with surgical tactics. These replicate the real-world surgeries for surgeons. They can also be used to educate the patients and explain the procedure by using XR content to simulate the before and after surgery scenarios.
- ▶ Virtual Reality too has its uses when it comes to the preparation phase of surgery. In fact, in 2021, VR was used to help in the surgical planning for a procedure to separate two twins who were born fused together at the head. Digital twins of the conjoined twins were viewed in VR prior to the procedure, to give surgeons greater understanding and advanced insights to analyze critical blood vessels and plan for the end goal of safely separating the twins.⁵

Surgery

- ▶ XR content with 3D holograms of MRI and CT scans can be used during the surgery as well for reading the scans while performing surgery and collaborating with experts from across the globe for collective opinion in real time.



Image credit: Surgical Theatre⁶

Pain Management

XR and VR can be used to reduce acute pain in various painful medical procedures like childbirth, colonoscopy, wound dressings, etc. It is proven to be most effective in significantly reducing pain in hospitalized patients. These therapies can engage patients and make them feel more like games rather than therapies, for them to get excited about instead of avoiding them. There are clinically proven VR therapies which can help rewire your brain to cope up with post-surgery pains thereby reducing the need for pain relievers.

NurtureVR is built upon virtual reality's ability to alleviate pain related to pregnancy, reduce stress, and promote overall wellbeing. It is designed to be offered to women beginning in their third trimesters. Using VR headsets in their homes, women access 14 weeks' worth of educational material, meditation capabilities and other immersive experiences, helping them with diverse topics including stress and pain management⁷



Drug R&D

Drug Development

XR technologies can be used for molecular visualizations and analysis of virus, drug discovery. Scientists can meet with their holographic colleagues in virtual environment to collaborate as if they are next to each other. These visualizations can help in generating greater insights by understanding the nuances when they can manipulate the molecules with their own hands which is far better experience than the traditional 3D glasses.

Clinical Trials

XR can improve the patient enrollments and retention by engaging them with immersive experience and help the patient/ caregiver in decision making about participating in a clinical trial and improve compliance to treatment. With storytelling capabilities in hybrid reality, it would enhance the impact of clinical trial outcome. Patients are more empowered and encouraged to participate and provide feedback from the comfort of their home.

Patient Visualization

With every encounter of the patient with a medical institution, reams of data that describe the patient condition such as body vitals, appearance, skin, organ state, information pertaining to different body systems (cardiovascular, alimentary etc.) along with observed anomalies and abnormalities are captured. XR can be used to organize and represent these data by overlaying on a virtual patient enabling healthcare professional to access the information easily. For example, a doctor can point to the heart of the virtual likeness of the patient in question, correlate diagnostic lab information with clinical observations and assess the condition of the heart.

Education & Training

For Healthcare professionals

XR applications can be used extensively in medical education for training and teaching purposes. These applications can help provide deeper understanding on the subject with intricate details of anatomy. This includes the ability to view problems/ situations from within(egocentric) or from outside(exocentric).

Collaborative learning is possible with idea exchange among multiple learners adopting avatars and interacting with each other in a virtual world. Game based XR applications can be used for teaching lessons quickly which are hard with physical education. Medical students can study surgeries and practice their skills on the XR platform.

For Patients

Patients can be educated on their health outcomes by following certain good practices and sticking to their care plans. They can be educated in multiple clinical and non-clinical settings to help them understand the illness visually for better cooperation and treatment.



The Future – Ruminations

With aiding technologies such as tactile sensors, devices, nanotechnology, etc. evolving at a rapid pace, we see the applications of XR to rise manifold. Some of them are:

Advancements in Surgery

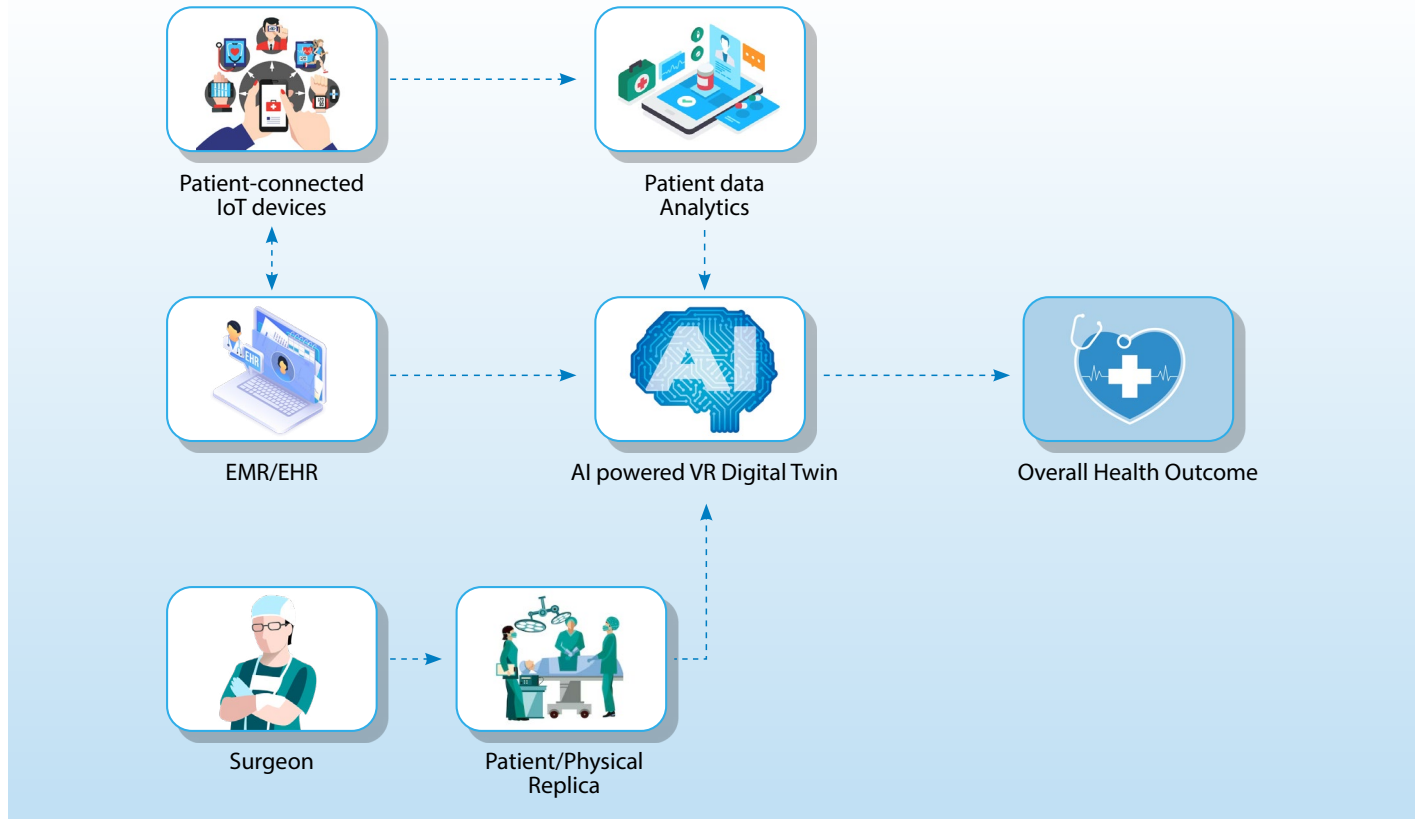
IoT devices interacting with VR Digital Twin to record the vitals and other critical parameters along with most sensitive data on conditions and update the records to build a well-trained model for predicting the impact to health outcome.

With high quality cameras and sensors, the doctors working on the Physical replica can reflect the operation on the virtual model (Digital Twin) to know the impact or outcome in advance based on the surgical steps and the preparation by doctors

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Advancements in Surgery with Digital Twin



Mental Condition

We can possibly use XR applications to record the situations which aggravate the emotions of patients and try to divert their attention with other signals or other content to avoid them to land into trouble. We can address multiple trigger points to record their behavioral patterns to predict the impact on their mental balance. Patients with conditions like phobias and psychological illness can be exposed to these tools programmed to reduce their symptoms by changing their course of action.

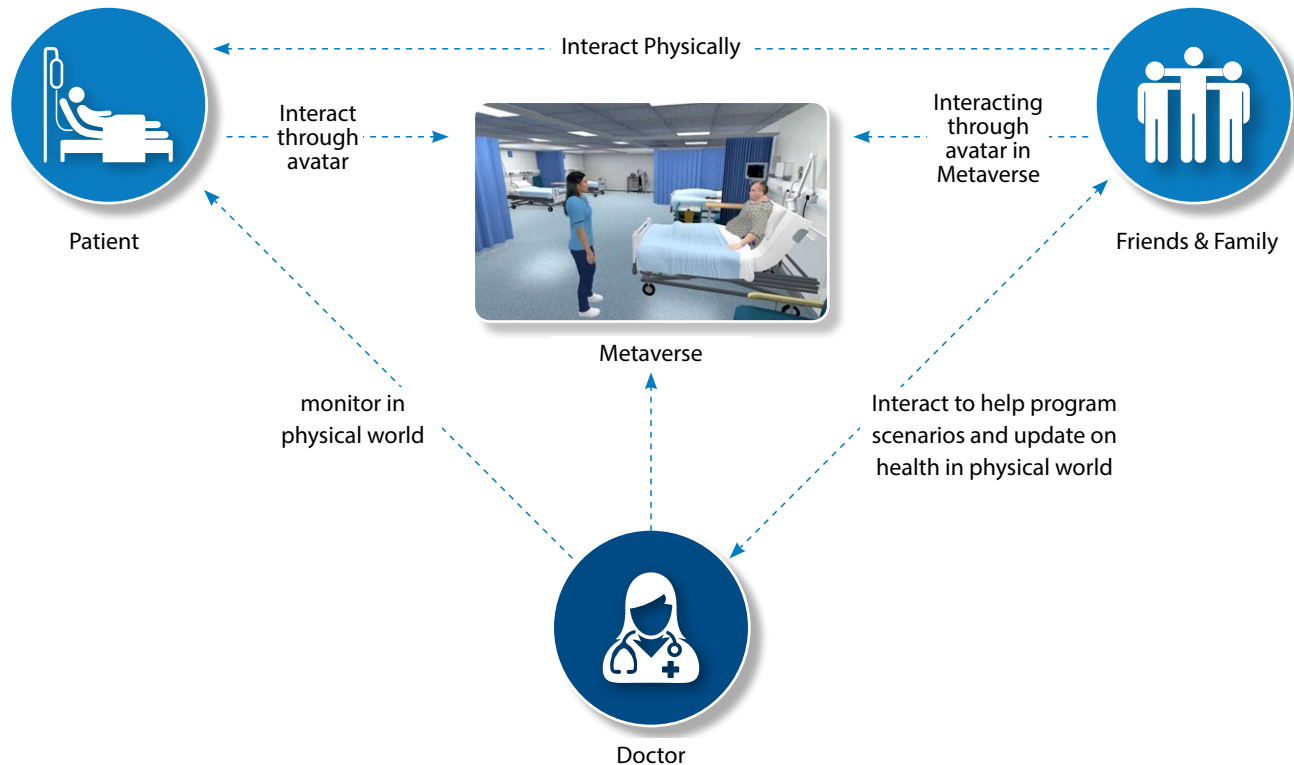
Prolonging life and Quality of life

For patients with terminal illness, XR can help in narrating the stories of hope and belief to tune their minds to have positive attitude towards life. It can be used in helping them with guides and other necessary content to uplift their quality of life.

Metaverse

A virtual healthcare environment in Metaverse can be leveraged for patients in hospice to live the rest of their life. The avatars of friends or relatives of their liking, other patients and healthcare staff can join the Metaverse through their avatars. The patients interact with them, communicate with them and live as if they are living real life. They would be given injections and medications as per the schedule and would be given reminders to eat physically and do other activities as in real life.

Patients living in Metaverse



Gamification in Metaverse

The patients can be motivated to keep themselves active and fit by rewarding them when they reach their health goals in compliance with their health plans. The physical activities can be tracked, and they would be rewarded with some special accessories or apparel to feel accomplished. Fitness challenges can be designed to compete with others in Metaverse to encourage and remind them to complete goals and get rewarded. After physical exercise or fitness goals, rewards would be given in virtual world to their avatars.

Rise of the bots

Nanobots, extremely tiny robots that operate at microscopic scale, have been a focus area of researchers especially in the field of medicine. The medical applications of nanorobots (nanobots) are thought to range from clearing blocked arteries to eradicating cancerous cells.

The possibility of nanobots with the ability to reach specific areas due to its size through guided navigation, switched on and transport drug molecules hold immense potential in detection of diseases through less invasive biopsies, treatment of diseases locally as well as performing surgeries. Despite the promise of nanobots and its application in medical field, the realization of nanobots that move through the human body, home in on the

targeted area and activate or perform the functions – detection, diagnosis, monitoring as well as treatment – is still in its early stages.

One of the key challenges is maneuvering nanobots in dynamic environment (human body) where factors such as body fluid viscosity, obstacles and presence of similar biomolecules dominate at microscopic scale. This is where XR can play an important part. The nanobots can be deployed by doctors with the use of AR and coupled with haptic feedback, the real-time positioning, adjustments, and maneuvering can be felt and hence controlled while at the procedure table.

Virtual reality involving virtual nanobots, biomolecules and virtual pathways will be used to develop, test and train the real nanobots thereby increasing the efficacy of surgeries and treatment.

Human-Computer Interface

Devices such as wrist bands and head bands, subcutaneous implants can scan the electrical signals and brain rhythms & record the patient's body vitals, which can then be transmitted to external processors and equipment. When combined with visual devices like VR headsets, it can help in rehabilitation, body training and even translating thoughts into actions in the real world. This will enable patients to reduce dependence on others for performing their daily chores.



XR Considerations

XR has the potential to reimagine patient engagement, treatment and revolutionize the way care is provided. As with other technologies, and especially for one that deals with life, the deployment and usage of XR in healthcare requires careful considerations. The main aspects to be considered for implementation of XR technologies in healthcare include security, privacy, affordability and ethical dimensions. Governments, regulatory bodies and all the healthcare players including technology players need to work together to leverage the full potential of XR and use it effectively for better health outcomes.

Security & Privacy

As the industry is evolving and becoming more digital with connected health tech devices enabled with XR, there is an increasing need to be aware of security risks as well. Healthcare interactions involve the collection and transmission of health data (PHI and PII data) that needs to be shared with multiple stakeholders and systems. For XR to be truly effective, systems need to be interoperable and with it arises the concerns of data security and privacy. While it improves patient care, more the points of access to patient health information, more the potential opportunities for the data to become compromised.

Bioethics

The use of XR in healthcare opens up new forms of human-technology interactions with ethical implications. This danger is especially true in the case of vulnerable patients - emerging XR systems should be developed keeping in mind the bioethical principles like autonomy, justice, beneficence, and non-maleficence.

Affordability, inclusivity and equity

Design and development of XR powered medical applications need to consider a diverse array of individuals cutting across gender, race, social strata, physical abilities and the like, so that it is beneficial to humankind as a whole. Considerations of usability, accessibility and pricing are critical in product development and policy making so as to ensure that no communities, social groups and regions are left behind.



Conclusion

Adoption of XR technologies in healthcare is growing and it is gaining its presence in modern healthcare facilities already. It is being used to drive advancements throughout the healthcare industry with innovative solutions that can benefit all the healthcare players. Some of the key solutions are in the areas of data visualization, anatomy mapping, Mixed Reality surgical navigation, collaboration with medical staff and generating insights from patient data. These advancements in health tech can reduce the dependency on drugs and assist both patients and healthcare professionals.

Though not without attendant risks and the need for regulation and oversight, XR holds the promise to make healthcare better, efficient and opens up vistas in improving the quality of human life. As immersive technology becomes more affordable and mainstream, the use of XR and applications in healthcare is expected to rise exponentially. Exciting times ahead!

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Bharath Koppolu, is a distinguished leader with 18+ years of IT experience encompassing a wide range of skill set, roles and industry verticals. He has extensive experience in leading large programs and business initiatives in the areas of Business Consulting, Program and Product Management for Healthcare organizations. He is currently working as a Principal Consultant at Infosys, leading the consulting practice for Healthcare and Life Sciences verticals at Microsoft practice. He is involved in various consulting engagements and building solutions for Healthcare and Life sciences Industries, in line with latest technological advancements and business trends.



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