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Exploring the Potential of Virtual Reality in the Management of Cardiac Diseases: A Systematic Review

Ashwini Vairale[1], Neha Ankireddy[2], Mahaboobi[3], Nagulapally Sanjana[4], Akanksha Bathula[5], Narender Boggula[6], Gaytri Devi Yasa[7]*
CMR College of Pharmacy, Kandlakoya, Medchal, Hyderabad, Telangana, India.

Corresponding Author:
GAYATRI DEVI YASA[7]
Assistant Professor,
Department of Pharmaceutical Chemistry,
CMR College of Pharmacy,
Kandlakoya, Medchal, Hyderabad, Telangana, India - 501 401.

Abstract:- With a virtual reality (VR) headset, a user may imitate an event or experience in a computer – generated setting. Immersive virtual reality simulations may be needed for the usage of gloves that offer sensory input or specialized 3-D eyewear with a screen. Numerous cardiology groups are using these advances for education, pre-procedural planning, intraprocedural visualization, and patient rehabilitation. To get the requisite dexterity and clinical competency, modern cardiac care involves progressively complicated percutaneous procedures and technical skills that call for extensive work hours and repeated practice. Cardiac interventions have a significant risk of serious consequences, therefore achieving successful results under pressure requires both appropriate technical competence and excellent team communication. VR technologies can play a significant part in this process. In this context, it is essential to have lifetime training and adequate exposure to these scenarios. The practice of clinical and technical skills training in the field of cardiac treatments can be completely transformed by VR technology. Individuals who experience an acute myocardial infarction (MI) are up to three times more likely than the general population (20-45% of patients with CVD) to exhibit symptoms of depression. Lately, the application of contemporary technologies- particularly those that function in virtual environments- has shown beneficial in the treatment of symptoms associated with anxiety and depression. Virtual reality (VR) improves accessibility in cardiology by making it easier to plan heart surgery or to consult with other exceptional cardiology professionals during procedures. Nonetheless, research on enhancing the benefits of rehabilitation using VR has also grown in popularity.

Keywords:- *Virtual Reality, Cardiovascular, 3-D, Anxiety, Depression.*

I. INTRODUCTION

➢ *Cardiovascular disease (CVD) and its rise*

Cardiovascular diseases (CVDs) are a group of disorders of the heart and blood vessels like heart attacks, strokes, etc. Globally, the number of cases of CVD has increased significantly in recent years, putting the general public at major risk for health problems. Numerous interconnected variables are contributing to the rising prevalence of cardiovascular illnesses. Stress, poor eating habits, and sedentary behaviour all contribute to risk factors like diabetes, hypertension, and obesity. These risk factors enhance the likelihood of cardiovascular illnesses considerably. The aging population is one factor contributing to the increased incidence of CVD in various parts of the world. As people live longer, chronic illnesses associated with aging are becoming increasingly prevalent.

Moreover, adding to the rising incidence of CVD is the aging population in multiple regions of the world. Chronic aging disorders like heart failure and atherosclerosis are turning out to be highly common as individuals live longer. To make matters bad, food habits and decrease of physical exercise have declined as a result of urbanization and industrialization. Tobacco smoking is prevalent in many countries across the globe. It raises the total burden of CVD and is a substantial risk factor. Because more resources are needed for diagnosis, treatment, and prevention, the rise in cardiovascular ailments has a substantial impact on healthcare systems. Public health programs encourage healthy lifestyles, increase knowledge of risk factors, and improve access to healthcare in an effort to halt the rising trend of cardiovascular diseases[1].

➢ *Description of virtual reality (VR)*

By indulging users in computer-generated atmospheres, virtual reality (VR) improves user experiences. Utilizing specialised equipment like VR headsets with high-resolution screens and motion sensors, virtual reality (VR)

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composes a dynamic and collective world. These headgear tracks users' every motion in real time, giving them a greater sense of presence. VR applications offer interactive training, teaching, and gaming simulations. In contrast to non-immersive VR, which incorporates augmented reality (AR) so users can interact with virtual elements while maintaining awareness of the actual world, immersive VR, as proven by devices like the Oculus Rift, completely immerses users in virtual worlds.

➢ *Interventions of VR in CVD*

Virtual reality (VR) has become a viable intervention in cardiovascular disease because of its creative methods to prevention and rehabilitation. Engaging experiences in virtual reality can encourage physical activity and heart health. Interactive virtual reality apps can improve adherence to prescribed regimens by assisting users in following customized exercise plans. Furthermore, by generating immersive environments for supervised exercise, virtual reality plays a significant role in cardiac rehabilitation. These sessions address psychological problems as well as physical well-being, reducing the stress and anxiety that are commonly associated with heart disease. Real-time monitoring is made possible by VR-based biomedical devices, enabling people to take control of their own lives and make educated decisions.

In the field of education, VR helps healthcare professionals simulate complex cardiac scenarios, improve diagnostic and intervention skills. This technology improves medical education and deepens understanding of cardiac anatomy and pathology. VR also improves patient education by enabling interactive visualizations that aid understanding of treatment plans and promote compliance.

Virtual reality-based relaxation techniques also lower stress and improve heart health. Immersion settings can be used as therapeutic instruments to support mental health and help manage cardiovascular disease overall. By allowing for the remote monitoring and consultation of cardiac patients, virtual reality integration with telemedicine broadens its application[2,3].

➢ *Rehabilitation*

For people recuperating from heart attacks or surgery, VR-based rehabilitation programs provide fun, adaptable workouts.

➢ *Stress reduction*

For managing cardiovascular risk factors, VR can be designed to cause relaxation and reduce stress.

➢ *Patient education*

In order to educate patients about cardiovascular anatomy, risk factors, and lifestyle modifications, VR simulations can be used.

➢ *Remote monitoring*

VR technology allows healthcare providers to track progress and intervene as needed, by facilitating the remote monitoring of a patient's cardiovascular health[4].

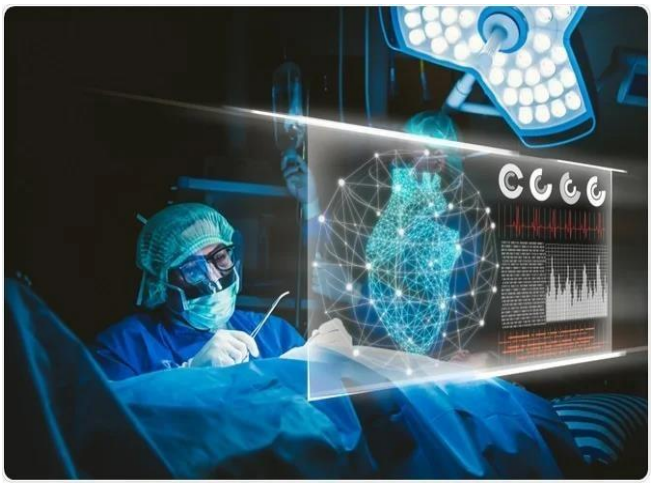

Fig 1: Virtual reality during heart surgery

II. ADVANTAGES OF VR IN CVD

➢ *Patient engagement and adherence:*

Virtual reality provides a cardiovascular rehabilitation environment that helps the patients to adhere to the recommended activities and lifestyle modifications.

Interactive monitoring: VR applications' interactive features and real-time feedback might help patients follow their treatment regimens more closely, which can enhance their general cardiovascular health.

➢ *Customized exercise regimens:*

Individualized recovery medical professionals may create personalized exercise regimens based on the specific needs of each patient and provide targeted treatment for specific cardiovascular diseases thanks to virtual reality.

Adaptive Difficulty Levels - VR systems provide the ability to dynamically modify the level of difficulty of exercises based on the patient's development, maximizing therapy without unduly taxing or straining the individual.

➢ *Stress Reduction and Mental Health:*

Virtual Relaxation Environments: Virtual reality (VR) helps with two critical components of managing cardiovascular disease they are stress reduction and mental health enhancement, VR does this by providing an immersive experience in a soothing virtual environment. Biofeedback integration- Patients can receive real-time access to stress-reduction techniques and insights through virtual reality applications that include biofeedback devices for monitoring and managing stress levels.

➢ *Research and data collection:*

Real-time data analysis- VR provides the health professionals with valuable information that helps in adjusting the treatment plans by collecting the real time data in patient interactions and progress. This helps to determine the effectiveness of VR in cardiovascular disease treatment.

➢ *Motivation and adherence:*

Gamification of Rehabilitation-VR apps can incorporate game components to create a fun and interesting cardiovascular rehabilitation process that boosts patient motivation.

Reward systems- Through the use of virtual prizes and accomplishments, healthy conduct can be reinforced and patients can be encouraged to participate in their CVD treatment regimens.

➢ *Telemedicine and Remote Monitoring:*

Remote Patient Monitoring- Virtual reality enables medical professionals to keep an eye on patients' heart rates and other vital signs, enabling prompt intervention and treatment plan adjustments.

Virtual Consultations- By enabling patients to visit with medical specialists virtually, access to cardiovascular treatment can be made easier and regular follow-up encouraged.

➢ *Rehabilitation in a safe environment:*

Risk-free simulation: Virtual reality (VR) reduces the possibility of damage and offers a secure rehabilitation setting, particularly for individuals with mobility limitations, by enabling patients to practice exercises and activities in a virtual setting.

➢ *Education and Lifestyle Modification:*

Virtual reality (VR) facilitates the development of interactive educational modules that assist patients comprehend the cardiovascular system, the significance of drug compliance, and the role that lifestyle modifications play in the management of cardiovascular disease.

Simulated Lifestyle Environments: To practice and reinforce heart-healthy lifestyles, patients can immerse themselves in simulated virtual reality environments, such as grocery shopping or cooking.

In conclusion, there are a number of benefits to using virtual reality technology in cardiovascular care, including more patient involvement, reduced fear, and customized therapy. In the end, these advantages result in improved treatment outcomes and an overall higher standard of care[5,6].

III. USES OF VR IN OTHER FIELDS AND TREATMENT MEDICAL

These are all top-notch uses of virtual reality (VR) gadgets in the medical field. Virtual reality has a signifying potential in several medical settings, increasing patient care and yielding better results.

- Pain management: VR distraction therapy has shown to be very useful in lowering patients' perception of pain during medical operations like chemotherapy, dental work, and wound treatment. Virtual reality (VR) can significantly reduce pain by taking the patient's focus off of their suffering and placing them in a virtual world.
- Mental Health Assessment: Virtual reality (VR) environments can recreate events that set off particular mental health symptoms, enabling medical professionals to see and evaluate patients' responses in real time. This can abet in the diagnosis and track conditions such as anxiety disorders, PTSD, and schizophrenia.
- Rehabilitation for Stroke Patients: VR-based rehabilitation programs offer individualized exercises and activities planned to improve motor function and coordination in stroke survivors. The interactive nature of VR allows for engaging and tedious practice of movements, which can quicken the recovery process.
- Exposure Therapy: VR exposure therapy provides a safe and controlled environment for individuals to resist their fears gradually. By gradually uncovering patients to anxiety-inducing stimuli, VR helps desensitize them and reduce the potency of their phobic reactions over time.
- Medical Training and Education: VR simulations suggest healthcare professionals a harmless environment to practice composite procedures and scenarios. From surgical simulations to emergency response training, VR enhances learning by providing real life scenarios and immediate guidance, ultimately improving clinical skills and patient care.
- Social Skills Training: VR environments can simulate social circumstances such as conversations, collaborations, and non-verbal communication cues. These simulations offer individuals with ASD a safe and controlled space to practice social interactions, interpret social cues, and learn appropriate reciprocation.
- Emotion Recognition: VR programs can embody scenarios where individuals with ASD can practice recognizing and elucidate facial expressions, tone of voice, and body language. By repeatedly engaging with these simulations, individuals can enhance their ability to understand and acknowledge others' emotions.
- Sensory Integration: VR settings may be customized to change sensory input such as noises, lighting, and textures for those with ASD who may have sensory sensitivities or provocations. This personalization allows people to progressively adjust to sensory stimulation, potentially lowering sensory overload and increasing comfort in real-world social settings.
- Personalized Intervention: VR platforms may be adjusted to match the unique requirements and preferences of people with autism. Therapists may modify the difficulty level of social scenarios, provide rapid feedback, and measure improvement over time, resulting in individualized intervention techniques for each client.
- Generalization of Skills: One advantage of VR-based treatments is the possibility of applying skills learnt in virtual environments to real-world situations. Individuals practicing social interactions in VR might transfer their newly gained

Overall, virtual reality appears to be a viable technique for helping people with ASD acquire important social and communication skills. VR therapies, by offering a secure, customized, and immersive learning environment, have the

potential to supplement standard therapy techniques and improve outcomes for ASD patients[7-9].

IV. OTHER FIELDS

- Gaming: VR gaming has altered dramatically the way players interact with virtual environments, offering without parallel levels of immersion and interactivity. Players can physically move within virtual spaces, interact with objects, and become involved in gameplay that feels more realistic and immersive than traditional gaming experiences.
- Education: VR is progressively used in education to create charming and interactive learning environments. Students can explore historical events, hunt through scientific concepts, or even conduct virtual experiments, promote huge understanding and recall the information through experiential learning.
- Architecture and Design: VR enables architects and designers to generate virtual models of buildings and spaces, allowing users to envision and experience designs in 3D before construction begins. This immersive approach eases better communication between stakeholders and helps identify the deformity or upgrade early in the process.
- Tourism and Travel: VR provides travellers with immersive virtual tours of destinations, hotels, and attractions, offering a preview of what to predict before booking a trip. These virtual experiences can aid travellers make more sophisticated decisions and enhance their overall vacation planning process.
- Automotive: VR allows engineers to view and test numerous designs and features as it is employed in the automobile sector to replicate car design and prototyping.
- Real Estate: VR allows the potential customers or tenants to view homes remotely and acquire a real feel of the area. It is used to make virtual property tours.

Retail- Virtual reality is utilized in retail to provide virtual shopping experiences that allow customers to browse and try on things before making a purchase.

Virtual reality is utilized in sports training to recreate game circumstances and enhance athlete performance. It also offers spectators unique experiences like virtual stadium tours and game viewing from various angles. Engineering and manufacturing employ virtual simulations and training, allowing personnel to perform complicated jobs in a safe and regulated environment. Artists and designers employ virtual reality (VR) to create immersive and interactive virtual art exhibits, pushing the frontiers of creativity and audience participation[10,11].

V. FUTURE OF VR IN CVD

The future of virtual reality in cardiac treatments has enormous promise for changing the face of cardiovascular care. By improving procedural precision, facilitating training and skill development, empowering patients through education and informed consent, enabling remote monitoring and telemedicine, and integrating with emerging technologies, VR has the potential to optimize procedural outcomes, improve patient experiences, and advance the field of interventional cardiology.

Working together among physicians, technologists, and industry partners is critical for realizing the full potential of VR in cardiovascular care. By collaborating to invent and amplify VR applications, stakeholders can ensure that this technology advances the field of interventional cardiology and eventually, benefits patients with cardiovascular disorders. As VR evolves and becomes more sophisticated, its impact on procedure results, patient experiences, and overall cardiac care will only increase.

Numerous research has proven that virtual reality improves education, physical rehabilitation, and mental wellness. Research on mental disorders has shown that virtual reality (VR) helps reduce pain, phobias and anxiety, PTSD, agoraphobia, claustrophobia, arachnophobia, and fear of driving or weeping. Physical therapy studies show that virtual reality (VR) improves upper extremity functions but has no effect on gait, manual dexterity, or balance. VR can help increase post-intervention knowledge and improve healthcare personnel proficiency during training[12,13].

VI. CONCLUSION

The benefit of virtual reality in the treatment of heart disease represents a metamorphic approach that goes ahead of traditional methods. By bidding for patient assurance, regulating individualized rehabilitation, considering psychological aspects, permissive remote examination, developing motivation via play, establishing safety in accelerated circumstances and bringing significant information to research, VR is developing as a versatile tool in the perpetuity of cardiovascular care. The immersive and collective nature of VR not only develops adherence to treatment arrangement, but also likely to reconsider heart disease management, contributing an encouraging opportunity for improved patient results and healthcare modernization.

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