



The New Era of **VIRTUAL REALITY** in Healthcare

When digital visionary Jaron Lanier's VPL Research, Inc. launched virtual reality in the mid-1980s, healthcare seemed an obvious candidate for the technology. But Lanier was ahead of his time: Early versions of headgear and gloves were heavy and awkward. Most PCs couldn't render digital worlds quickly enough without compromising the detailed experience VR promised, while hardware and software were prohibitively expensive for all but a handful of academic medical centers.

Most importantly, there was no evidence VR played a role in improving patient outcomes or reducing costs.

Flash forward 30 years and the situation has changed. VR is getting a second life in healthcare, bolstered by ongoing research and published studies¹ with significant findings for therapies, medical training and patient engagement. Hospitals from Tufts Medical Center in Boston to Cedars-Sinai in Los Angeles are adopting advanced VR applications used by clinicians and patients alike.

With today's powerful technology and sophisticated software, patients, medical students, physicians and researchers are the beneficiaries of the new era of virtual reality in healthcare.

A virtuous circle

One characteristic of this new era is the virtuous circle of scalable technology. As adoption grows, hardware cost – both general-purpose computing and healthcare-specific devices – has tumbled. In just the past year, the price of a healthcare VR headset has dropped from \$1,200 to under \$500. The relentless logic of Moore's law continues to increase computing power and decrease its relative cost at an exponential pace.

With this momentum, innovative healthcare startups are developing solutions to address new opportunities. Futurists Sarbjit Nahal of BofA Merrill Lynch Global Research and Joseph Quinlan of U.S. Trust include VR in their top five healthcare innovations in 2017, while Grand View Research predicts healthcare VR will be a \$5 billion industry by 2025.²

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Moty Avisar | CEO and Co-Founder | Surgical Theater

VR has matured beyond mere innovation. Every day, thousands of patients are using it to reduce chronic pain, overcome phobias and crippling anxiety, and become better educated and more involved in their own healthcare. With VR, physicians are visualizing tumors, planning and conducting difficult surgeries, and improving diagnoses. Medical students, the next generation of physicians, now expect VR training before graduating.

Surgical planning

VR already has a foothold in surgical planning. Like pilots using a flight simulator to hone skills and practice what-if scenarios, surgeons use three-dimensional environments to plan complex surgeries and determine optimal paths and outcomes. They are sharing these immersive environments with patients to alleviate anxiety about procedures, discuss potential benefits and improve patient consent.

“It’s a scary moment for the patient,” says Moty Avisar, CEO and Co-Founder of Surgical Theater, a leading healthcare VR developer. “A 360-degree virtual environment, created from the patient’s own CT and MRI scans and anatomy, that shows a tumor and the planned operation is helping overcome that.”

The flight simulator analogy is apt – Avisar is an experienced fighter pilot who served with the Israeli Air Force and a specialist in developing realistic flight simulations.

“In the Air Force we rendered satellite images into a volumetric 360-degree rendering to enable pilots to immerse with their mission and targets – the threats, the angles,” Avisar explained. “We took the same concept in healthcare, combining images from CT and MRI to create a 360-degree immersive environment for the patients and surgeons.”

Surgeons navigate that patient environment using equipment from Oculus, HTC and HP. Virtual objects can be manipulated while viewed with headsets or on large displays. “A surgeon can literally walk down the path to remove a tumor before ever beginning a surgery. Hospitals see a significant economic value when patients choose to stay because it uses VR – and by providing an exceptional patient experience,” Avisar said.

Published studies suggest that VR in planning has tangible benefits. The authors of one such article concluded that while observation “still allows for surgical improvement, direct practice on a virtual reality trainer provides better results.”³

Beyond the published studies, the early adopters among leading providers are studying their outcomes and reaching similar conclusions. They report increased efficiency in the planning process and a reduction in the time it takes to complete surgeries. This in turn, may soon lead to documentable improvements in patient outcomes, as reductions in surgical time minimize stress on the body and mitigate potential exposure to infectious diseases.

A new tool of expertise

In 2014, Matthew Bramlet, MD, a Pediatric Cardiologist and Director of Jump Simulation Advanced Imaging and Modeling at OSF Healthcare, printed his first three-dimensional heart from MRIs and CT scans. Unexpectedly, it revealed an abnormality that forced surgeons to revise plans for an upcoming procedure. In its first incarnation, the 3D heart “changed our medical decision-making,” Bramlet said. “That’s when we knew we were on to something.”

There was one problem – printing didn’t scale easily. Seeking an alternative, Bramlet turned to virtual reality. “We knew that when a surgeon held



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a 3D printed heart in his or her hand, it would lead to better outcomes,” he said. “We found we could replicate the same value created by the 3D printed heart in a virtual environment.”

Beyond the value of scale, the VR approach also introduces new opportunities for simulation that a printed model does not afford. Physicians can practice and experiment in a lifelike environment without ever exposing patients to experimental risk.

Bramlet is applying that lesson more broadly, using VR to “democratize the transfer of knowledge at scale.” His premise: Some of the most powerful, creative thinking occurs for doctors at the peak of their careers – those famous “ah-ha!” moments. But because they are unpredictable, those epiphanies are difficult to share. Bramlet has just launched a company, ENDUVO, focused on solving this problem.

“When you capture and share that knowledge in a real-world, 3D setting, it becomes an incredible educational experience,” Bramlet said. “To scale, educators need to asynchronously impart all that knowledge throughout a workplace – we wanted to develop a tool that could transfer knowledge broadly while delivering an entirely new teaching and learning experience.”

For example, Bramlet said, doing an ultrasound of a shoulder is not a common experience, so it requires on-the-job apprenticeship. “That’s not something you can scale – unless you take a VR approach, where the 3D object is created, recorded and played back whenever and wherever it is needed,” Bramlet said. “With the ENDUVO platform and tools, educators bring their teaching materials and models into a virtual environment, enabling students to live, and learn, in a 3D-world.”

Bramlet has had no problem convincing healthcare executives of the system’s direct ROI. Adoption becomes obvious “as soon as we identified that it costs some hospitals \$2 million to train staff and we are able to drive a VR solution down to \$50,000 to \$100,000 a year.”

Therapeutic uses

VR has proved itself of therapeutic value over the past decade, with a mounting body of evidence supporting the wider adoption of VR as a standard treatment for chronic pain and rehabilitation. In one recent study, patients reported a 60 to 70 percent pain reduction during treatment, with benefits lasting up to 48 hours post treatment.⁴

Developers such as Firsthand Technology have created immersive experiences that incorporate biofeedback for patients experiencing pain that provide as much relief as, or even outperform, other treatments, including prescription opioids. These solutions “are helping patients through painful hospital procedures, improving recovery post-surgery, and helping chronic pain patients better manage their pain without drugs,” said Firsthand CEO Howard Rose.

Rose said VR environments activate sensory and perceptive systems, reducing both the physical experience of pain as well as the related stress, anxiety and depression that many patients suffer.

“Brain scan studies have shown that VR significantly reduces brain activity in areas associated with pain and increases positive activity in brain areas for cognition and resilience,” Rose said. “The finding that VR profoundly affects brain activity supports the potential for VR therapies that deliver lasting benefits for chronic conditions through brain plasticity and inducing neurological changes.”



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VR is also being used in mental and behavioral health settings. The University of Southern California’s Institute for Creative Technologies has developed a VR game that treats veterans suffering from post-traumatic stress symptoms. “Bravemind” is just one of many VR applications that elevate the impact of exposure therapy by enabling the patient to safely simulate, rather than simply imagine, the original traumatic experiences.

The next step forward

“All the forces necessary to increase significant adoption of VR for healthcare are finally coming together,” said Rose. “The health industry is becoming increasingly aware of the evidence for VR interventions, increasing the readiness to adopt VR into the flow of patient care. And VR technology has recently become simpler, more affordable and easier to implement in clinical settings.”

HP, for example, has been fine-tuning VR devices such as headsets for higher resolutions, lighter weight and sanitizable interior padding. These

healthcare-specific modifications ensure that the technology is suitable for patient environments, regular clinical use and comfort.

While providers sometimes build their own VR systems using consumer-grade devices and CPUs, vendors are bundling and pre-kitting systems to guarantee compatibility and high performance. Partnerships with VR developers support a plug-and-play approach that reduces uncertainty.

Bramlet sees VR as self-perpetuating technology – the more it is used, the greater its possibilities. “Get the technology in the door,” he advised, “and clinicians will start asking how it can be used to improve other decision-making processes.”

“This will become the standard of care,” Avisar agreed. “In five years, every patient will expect this.”

¹ In 2014, a Pubmed search generated 720 articles on virtual reality. By January 2018, that number had increased tenfold, to 7,212.

² “The Rise of High-Tech Healthcare: 5 Trends to Watch,” Merrill Lynch, <https://www.ml.com/articles/the-rise-of-high-tech-healthcare-trends-to-watch.html>.

³ François Schmitt, Aurora Mariani, Emilie Eyssartier, Jean-Claude Granry, Guillaume Podevin, “Skills improvement after observation or direct practice of a simulated laparoscopic intervention,” Journal of Gynecology Obstetrics and Human Reproduction (2017 Dec 29): pii: S2468-7847 (17) 30268-4. [Epub ahead of print].

⁴ Ted Jones, Todd Moore, James Choo, “The Impact of Virtual Reality on Chronic Pain,” PLoS ONE 11(12) (December 20, 2016): e0167523, <https://doi.org/10.1371/journal.pone.0167523>.



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