Virtual Reality as an Adjunctive Treatment to Opioid Therapy in Pain Management and Implications for Addressing the U.S. Opioid Epidemic

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INTRODUCTION

Pain management remains a persistent challenge for healthcare systems, with opioids historically forming a central component of treatment across primary and secondary care settings. Despite its effectiveness in analgesia, opioid-based therapies carry substantial risks, including tolerance, dependency, adverse events, and misuse. In the United States, the opioid crisis has resulted in more than 806,000 overdose deaths between 1999 and 2023, spanning both prescription and illicit use [1]. As a result, there is an increasing interest in adjunctive, non-pharmacological interventions that can be integrated, and consequently reduce overall opioid use.

Virtual reality (VR) has emerged as a promising adjunctive non-pharmacological intervention for patients on opioid pain relief suffering from acute and chronic pain. VR based digital therapeutics have received U.S. Food and Drug Administration (FDA) clearance for pain-related indications in 2021 [2]. EaseVRx, now marketed as RelieVRx following FDA De Novo authorization in 2021 (a pathway for low-to-moderate risk medical devices without a prior comparator), represents the first FDA-authorized prescription VR therapy for chronic pain[2]. VR interventions can help modulate pain perception and pain interference by using immersive distraction to shift attention away from pain signals [3] and reduce pain-related anxiety through relaxation and cognitive reframing [3]. Emerging evidence suggests that, when used adjunctively, VR may reduce pain intensity and psychological distress.

Figure 1: An image depicting a patient undergoing VR therapy in a hospital setting[15] .

METHODS

This poster is based on a selective examination of four published studies, evaluating VR as an adjunctive intervention to opioid-based pain management across inpatient and outpatient settings. We conducted a thematic analysis of clinical effectiveness, patient-centered outcomes, economic value drivers and equity considerations reported across the selected clinical studies. Key clinical effectiveness measures included opioid use quantified using morphine milligram equivalents (MME), pain reduction, pain intensity, and patient-centered outcomes such as patient satisfaction. In the post-surgical study by Pandrangi et al. (2022), opioid consumption was reported in MME, a standardized metric in which negative values indicate reductions relative to baseline [4]. In the same study, pain scores were measured by a 0-10 self-reported numerical rating scale [4]. Patient satisfaction outcomes were assessed in one chronic pain trial by Garcia et al. (2021) using a 6-point Likert scale (0 = strongly disagree to 5 = strongly agree), capturing ease of VR use, enjoyment, perceived benefit for pain coping, and willingness to continue VR use, with item scores aggregated into an overall satisfaction measure, along with pain intensity outcomes measured using a Numeric Rating Scale (0 = no pain to 10 = worst possible pain) [5]. Pain intensity outcomes with VR were measured in an inpatient study by Spiegel et al. (2019), also using a Numeric Rating Scale, including immediate and incremental pain reduction over time [6]. A randomized controlled trial (RCT) by Maddox et al. (2024) reported results on pain intensity and pain interference, allowing assessment of VR's impact not only on pain severity but also on functional and day-to-day pain related disruption [7].

RESULTS

Study 1 – Clinical Effectiveness - Post Head & Neck Surgery [4]

Pandrangi et al. (2022) conducted a study in 29 post–head and neck surgery patients, comparing interactive VR gaming delivered via an Oculus Quest headset (n = 14) with a 2D smartphone-based gaming control (n = 15) [4].

- Adjunctive VR produced clinically meaningful pain score reductions immediately and up to 3 hours [4].
- VR was associated with reduced post-intervention opioid use, including -9.10 MME (95% CL – 15.00 TO -1.27) at 4 hours and at 8 hours -14.00 MME (95% CI -25.60 TO -2.40) [4].

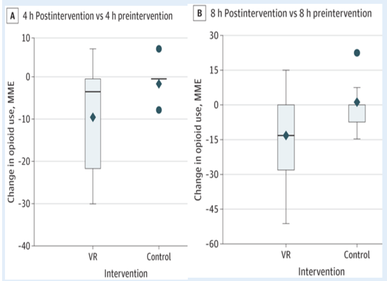

Figure 2: Changes in mean score. Panel A represents this at 4 hours post-intervention and Panel B at 8 hours post-intervention. VR group represents greater opioid use reductions in both 4 and 8 hours post-intervention, indicating an opioid sparing effect [4].

Study 2 – Clinical Effectiveness & Patient-Centered Outcomes - Chronic Lower Back Pain [5]

Garcia et al. (2021) conducted a double-blind, randomised, placebo-controlled study (N=179) of a daily 56-day adjunctive EaseVRx VR programme vs adjunct sham 2D VR games [5]. The population was largely Caucasian (90.5%) and college-educated (91.1%), with a mean age of 51.5 years [5].

- Pain intensity reduced by 42.8% (VR) vs 25.1% (sham) [5].
- 65% of EaseVRx patients achieved ≥30% pain reduction vs 40% in the sham group [5].
- User satisfaction higher in treatment group (4.32 vs 3.46; *P*<0.001) [5]
- Substantially reduced use of over-the-counter analgesic medication post-treatment in EaseVRx [5]

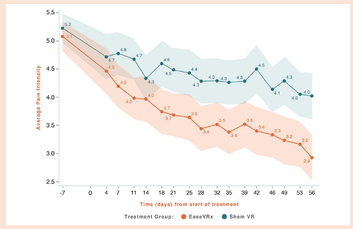

Figure 3: Average pain intensity. EaseVRx group show a greater and more sustained reduction in pain intensity over time, compared with the sham 2D VR group [5].

Study 3 – Clinical Effectiveness & Patient Centered outcomes - Pain in Hospitalized Patients [6]

Spiegel et al. (2019) reported results from a prospective, randomized comparative study in 120 hospitalized patients with pain scores ≥3/10, comparing an adjunct virtual reality intervention delivered via a Samsung Gear Oculus headset (N = 61) with standard adjunct health and wellness television viewing in the control group (N = 59) [6]. Pain was assessed and recorded by nurses at baseline, immediate post-intervention and at 48 and 72 hours [6]. Results showed that VR produced a statistically significant reduction in pain scores compared with control at all measured time points, with the effect most pronounced in patients reporting severe baseline pain (≥7/10) [6].

Outcome	VR Group	Control Group	*P*-Value
Immediate pain reduction (pre vs. post) Mean within-subject change	-1.72 pts (SD 3.56)	-0.46 pts (SD 3.01)	P < 0.04
Pain reduction in severe pain subgroup Baseline pain ≥7/10	-3.04 pts (SD 3.75)	-0.93 pts (SD 2.16)	P = 0.02
Incremental pain reduction at 48 hrs Adjusted regression (vs. control)	-0.59 pts	ref	P = 0.03
Incremental pain reduction at 72 hrs Adjusted regression (vs. control)	-0.56 pts	ref	P = 0.04

Table 1: VR shows greater pain reduction vs control across multiple timepoints [6] .

Study 4 – RelieVRx (formerly EaseVRx) for Chronic Low Back Pain [7]

In a study by Maddox et al (2024), which included 1,067 adults with chronic low back pain, it was reported that participants receiving the adjunctive RelieVRx immersive VR program in an in –home setting demonstrated statistically significant and clinically meaningful pain improvements compared with adjunctive active sham VR at the end of the 8-week intervention [7].

- Mean pain intensity decreased by approximately 2.0 points on a 0–10 numerical rating scale in the RelieVRx group, exceeding commonly accepted [7] thresholds for clinical relevance
- Pain interference decreased by approximately 2.3 points, with RelieVRx showing clear superiority over active sham VR [7]

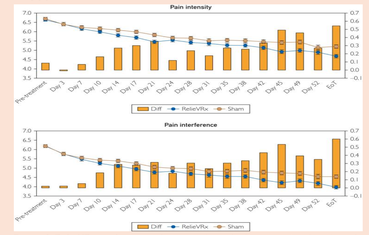

Figure 4: RelieVRx vs sham over time: greater reductions in pain intensity and interference with VR, with increasing between-group differences (Diff) toward end of treatment [7].

OBJECTIVES

This poster synthesizes evidence on VR as an adjunctive, potentially opioid-sparing intervention for acute and chronic pain, emphasising:

1. **Clinical effectiveness (pain reduction outcomes)**
2. **Patient-centered outcomes (function, satisfaction, and tolerability)**
3. **Equity considerations that share adoption in the U.S.**
4. **Economic value drivers and evidence gaps for cost-utility analysis**

DISCUSSION

1. Clinical Effectiveness

In acute and inpatient populations, VR produced rapid and clinically meaningful pain reductions, with effects strongest in patients with higher baseline pain severity. Pandrangi et al. (2022) provided direct evidence of opioid-sparing potential, with statistically significant reductions in post-intervention opioid use (MME) at 4- and 8-hours following head and neck surgery [4]. In chronic pain populations, RelieVRx (formerly EaseVRx) clinically meaningfully reduced pain intensity and pain interference, exceeding accepted thresholds for clinical relevance and outperforming active sham VR, indicating effects beyond distraction alone [5, 7]. While opioid use was not a primary endpoint in chronic pain trials, improvements in pain interference and reductions in concomitant analgesic use suggest an indirect pathway toward opioid-sparing benefits.

2. Patient-Centered Outcomes

Across the four studies patient-centered outcomes were consistently favorable, indicating high acceptability and tolerability of adjunctive VR across all settings. While acute inpatient studies primarily demonstrate reductions in pain intensity, chronic pain trials such as Garcia et al. (2021) and Maddox et al. (2024) extended these findings to patient-centered outcomes, showing improvements in pain interference across daily activities, sleep and emotional wellbeing [5 7]. In the inpatient setting, VR was particularly effective among patients reporting severe baseline pain, supporting its value for high burden subgroups. The EaseVRx group reported greater likelihood to recommend VR to someone else compared to the Sham VR group (8.72 versus 6.55, respectively; P<.001) [8]. Finally, EaseVRx participants reported greater likelihood to continue using VR if they could keep their headset compared to Sham VR (9.18 versus 7.23, respectively; P<.001) [8]. No major safety concerns were reported across all studies; however, some patients may experience headset-related discomfort or prefer faster-acting pharmacological relief, which could reduce adherence and compliance if VR is scaled without appropriate patient selection and support.

3. Equity Considerations

From an equity standpoint, VR was evaluated in predominantly middle-aged adult populations spanning acute inpatient and chronic outpatient settings, with more limited demographic reporting in acute care studies and reduced racial and socioeconomic diversity in chronic VR trials. Garcia et al. (2021) recruited a predominantly White (90.5%), college-educated cohort with a mean age of 51.5 years, which is characteristic of a wider concern in the VR pain literature [5]. UCSF and AppliedVR has showed VR therapy has been primarily tested in well-resourced settings serving non-Hispanic White patients with high educational attainment, while historically marginalised populations (who often bear a disproportionate burden of chronic pain and face greater barriers to analgesic access) remain underrepresented [9]. An FDA-supported usability study found that while VR was broadly acceptable to diverse patient groups, significant adaptations were needed to address the needs of low-income, racially diverse populations, including language support, digital literacy support and culturally relevant content [10]. This equity gap raises questions about whether VR can fulfil its potential as a tool to reduce health disparities or whether, without deliberate intervention, it risks widening them. Plus, VR is inherently a non-blindable intervention, creating performance and detection bias across all studies. As a review and meta-analysis highlighted, performance bias is essentially non-assessable in VR trials, and detection bias remains difficult to evaluate due to biased, self reported pain scores. [11]

4.Economic Value

The opioid sparing effect reported by Pandrangi et al is economically relevant, as reduced opioid consumption may lower medication costs and adverse event management. Supporting this, a 2024 meta-analysis of randomized trials estimated mean pain-management–related cost savings of approximately $5.40 per patient associated with VR interventions (95% CI −$11 to $156), suggesting potential economic value but highlighting substantial uncertainty and the need for prospective cost-utility endpoints [13]. In addition, an economic analysis modelled that inpatient VR programmes could be cost-saving mainly through reduced hospital length of stay, but that savings from reduced opioid use alone were insufficient to offset VR implementation costs [12]. A more recent health-economic analysis (2025) estimated that VR must reduce opioid use at discharge by at least 2.8% to achieve cost-effectiveness at a €20,000/QALY threshold [14]. Critically, most studies lack standardized utility-based measures such as the EQ-5D.

Conclusion: While virtual reality is not a direct replacement for opioid therapy, the evidence reviewed suggests it may serve as a valuable adjunctive intervention across acute and chronic pain settings. Future studies prioritising prospective opioid-use endpoints, standardized utility measures and diversifying patient populations will be critical to inform payer, policy and access decision-making.

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