# Virtual Reality for Upper Limb Stroke Rehabilitation: A Quality Improvement Study Evaluating Patient Outcomes and Clinical Feasibility

**E. Dunn[1], D. Quinn[1], J. Bray[1], C. Wilson[1], N. Keaveny[1], D. Holmes[2], D. Charles[3], & S. Poulter[3]**

*[1]Belfast Health and Social Care Trust, Occupational Therapy Department, Royal Victoria Hospital, Belfast, BT12 6BA, Northern Ireland | [2]eXRt Intelligent Healthcare, Belfast, Northern Ireland | [3]School of Computing, Ulster University, Jordanstown, Northern Ireland*

[1]emma.dunn@belfasttrust.hscni.net, [2]dominic@exrt.io, [3]dk.charles@ulster.ac.uk, s.poulter@ulster.ac.uk

**DOI:** 10.54337/aau.icdvrat26.04

## Abstract

Upper limb impairment affects most stroke survivors, yet routine rehabilitation often provides far fewer repetitions than the 300–800 movements linked to neuroplastic change. This extended abstract reports a dual-phase Quality Improvement study examining whether a commercial, controller-free virtual reality system could increase therapy dose in an acute stroke unit without unacceptable workflow burden. Four stroke patients completed matched 30-minute conventional occupational therapy and VR sessions, while 18 occupational therapists assessed feasibility through usability scales, competency checks, and interviews. VR produced 200–500% more repetitions, median 354%, with positive feedback, no adverse events, and good usability, though supervised practice remained necessary afterwards.

## 1. Introduction

Stroke remains a major source of long-term disability, and upper limb impairment affects around 70% of survivors Langhorne et al. (2011). Recovery is strongly linked to high-dose, task-oriented practice, yet observational work shows that conventional stroke rehabilitation often delivers only a few dozen meaningful upper limb movements per session Lang et al. (2009). More recent observational work reports somewhat higher but still sub-threshold counts, ranging from around 36–57 repetitions in a recent systematic review to a mean near 210 in a detailed video analysis Newton et al. (2023), Proulx et al. (2025); the conventional counts observed here fall within this contemporary range. Translational and clinical rehabilitation literature suggests that substantially larger numbers of repetitions, often in the range of 300–800 movements, are needed to drive the neuroplastic adaptation associated with motor recovery Birkenmeier et al. (2010).

This mismatch between evidence-based dose targets and routine clinical delivery is especially problematic in acute stroke services, where therapist time, patient fatigue, and ward pressures restrict opportunities for intensive practice. Virtual reality has been proposed as a way to narrow this dose gap by combining structured exercise with immediate feedback, performance tracking, and game-like motivation Bui et al. (2021), Hao et al. (2024). However, successful adoption depends on more than efficacy alone: systems must also be usable, safe, and workable for busy clinical teams.

This paper presents a dual-phase Quality Improvement study undertaken at the Royal Victoria Hospital Acute Stroke Unit, Belfast. The study evaluated *Resynk*, a commercial VR platform for upper limb stroke rehabilitation that runs on Meta Quest 2, 3, and Pro and uses controller-free hand tracking. Two practical questions guided the work:

1. Can VR increase upper limb repetition counts by at least 20% relative to conventional therapy without additional staffing?
2. Is the system sufficiently usable and acceptable for occupational therapy staff to incorporate into routine care?

## 2. Method

### 2.1. Design and Setting

The study used a Quality Improvement (QI) design rather than a randomised controlled trial. This approach better reflected routine ward practice and produced findings that were more applicable to implementation. The work was conducted in the 31-bed acute stroke unit at the Royal Victoria Hospital

### 2.2. Participants

Eight patients were recruited to the efficacy phase over six months. However, one was discharged early, one moved to another hospital and two did not achieve a 30 minute session length used for comparison, so four patients completed the study. Inclusion criteria required confirmed stroke, age over 18 years, an identifiable upper limb deficit, ability to follow simple commands, and capacity to consent. Exclusion criteria included acute medical instability, global aphasia, active delirium, uncontrolled hypertension, seizure history, significant vestibular risk, and implanted devices that would preclude headset use.

Eighteen of nineteen eligible occupational therapists from acute and community stroke teams took part in the feasibility phase. One therapist declined because of workload pressures.

### 2.3. Intervention and Measures

*Resynk* provides nine upper limb rehabilitation games targeting movements such as reaching, grasping, supination, pronation, and pinching. A companion web application allows therapists to set patient profiles, prescribe games, define daily goals, and review repetition counts. The controller-free design was a key implementation feature because many acute stroke patients cannot reliably grip handheld controllers.

For the patient phase, participants received 30-minute VR sessions two to five times per week during admission. The platform automatically logged repetition counts. For comparison, two 30-minute conventional upper limb occupational therapy sessions per patient were observed, and repetitions were manually counted by an additional therapist using tally counters.

For the staff phase, feasibility was examined using a Technology Acceptance Model framing. Measures included the System Usability Scale (SUS), post-training and one-month competency checklists, and semi-structured interviews about safety, barriers, and support needs. Quantitative patient outcomes were summarised descriptively, with paired comparisons assessed using the Wilcoxon Signed-Rank Test because of the small sample and non-normal rehabilitation data.

## 3. Key findings

The patient phase showed a substantial increase in upper limb practice intensity when VR was used as an adjunct to routine therapy. Across participants, VR produced 200–500% more repetitions than conventional sessions, with a median improvement of 354%. This comfortably exceeded the study's target of a 20% increase. The intervention also improved attainment of the minimum neuroplastic threshold: VR sessions reached between 33% and 232% of the 300-repetition benchmark, whereas conventional sessions achieved only 8% to 33%. Table 1 provides a condensed summary of the main patient efficacy and staff feasibility outcomes.

The detailed cases help explain the practical value behind these numerical gains. An 82-year-old participant with marked weakness engaged successfully despite needing facilitation. Another patient with fine motor coordination difficulties achieved the highest repetition counts, apparently aided by the competitive structure of the games. A third patient with motor and perceptual deficits was able to practise both domains within the same activity. These cases suggest that benefit was not confined to a narrow patient subgroup.

Subjective responses were also favourable. Most patients rated the VR sessions as a positive experience, and most agreed or strongly agreed that the system motivated them to do more rehabilitation because it was more interesting than standard exercises. Importantly, no adverse events were reported. In an acute stroke context, where concerns around dizziness, tolerance, or cognitive overload often obstruct adoption, the absence of safety issues is a notable implementation signal.

Staff feasibility results were similarly positive overall. The average SUS score was 81, which falls in the good-to-excellent range and exceeded the predefined threshold of 70. Interview data highlighted enthusiasm for the motivational quality of VR and its potential to add therapy intensity without constant one-to-one therapist delivery. At the same time, the competency checks clarified where implementation friction remained. Immediately after training, all staff could independently use the headset and web application. At one-month follow-up, however, more routine administrative tasks such as logging in, creating profiles, or editing goals sometimes required verbal prompting. This pattern indicates that the core concept was acceptable, but operational reliability depended on reinforcement.

## 4. Discussion

The study supports the view that clinically designed VR can narrow the rehabilitation dose gap in acute stroke care when it is used as an adjunct rather than a replacement for conventional occupational therapy. The findings align with broader evidence that VR can improve engagement and increase opportunities for upper limb practice Hao et al. (2024), and with recent meta-analytic work suggesting that VR combined with standard rehabilitation is more effective than VR alone Enríquez-Canto et al. (2025). The practical significance of the present study lies in its service-facing emphasis: it examined not only whether repetitions increased, but whether a real ward team could absorb the system into routine work.

Several design features appear central to that feasibility. First, hand tracking reduced an obvious access barrier for patients with weak or impaired grip. Second, the gamified structure supported motivation through immediate feedback, scoring, and progressive challenge, which is consistent with established accounts of VR's rehabilitation value Bui et al. (2021). Third, the therapist dashboard made it possible to prescribe tasks and monitor activity in a clinically meaningful way rather than treating the technology as a generic entertainment device Adams et al. (2015).

The work nonetheless has clear limitations. Repetition count is an intermediate, process-level outcome rather than direct evidence of functional recovery: a higher dose is a necessary condition for, but not a guarantee of, improved upper limb function Lang et al. (2016). Encouragingly, a recent systematic review suggests that dose increases of at least 200% may be required before meaningful functional gains emerge Patel et al. (2026), a range within which the present 200–500% increases fall, although confirming functional benefit would require impairment- and activity-level measures beyond the scope of this study. The study was also single-site with a small patient sample (four of eight recruited completed the matched comparison) and no randomised control group or blinding, so the gains cannot be separated from novelty or attention effects. VR and conventional repetitions were recorded by different methods (automated logging versus manual tallying). Repetition counting was performed by 2 therapists. The 18 therapists who used the VR separately with patients were to be able to give feedback but not with the same patients where the repetitions were original counted The results should therefore be read as preliminary implementation evidence that motivates rather than substitutes for a larger randomised controlled trial with blinded functional outcome assessment.

From an implementation perspective, the main lesson is that training cannot be a one-off event. The one-month competency decline suggests that successful deployment requires that practice be supported by further expert supervised training as staff need to feel comfortable and confident when using it. Access to quick-reference materials, and simplified login workflows was also considered important. For services considering adoption, VR appears most credible as a structured supplement delivered for 20–30 minutes, three to five times per week, targeted at patients who can follow simple commands and tolerate headset use. Staff newer to stroke rehabilitation demonstrated strong technological skills but required additional support with clinical reasoning for appropriate VR application. This suggests that training programmes must address both technical operation and therapeutic integration.

| Domain | Outcome |
|---|---|
| Patient efficacy | VR increased repetitions by 200–500% versus conventional therapy; median increase 354%. |
| Representative repetition counts | Patient 1: 25 to 110; Patient 2: 100 to 696; Patient 3: 27 to 98; Patient 4: 54 to 171. |
| Dose attainment | VR reached 33–232% of the 300-repetition threshold; conventional therapy reached 8–33%. |
| Patient experience | Most patients reported VR was a positive experience and increased motivation for rehabilitation. |
| Safety | No adverse events reported by patients or staff. |
| Usability | Mean SUS score 81; 16 of 18 staff scored the system at 70 or above. |
| Competency retention | Immediate post-training competency was 100%; at one month, setup and login tasks required prompts for some staff. |

*Table 1: Condensed summary of patient efficacy and staff feasibility outcomes.*

## 5. Conclusion

This Quality Improvement study indicates that controller-free VR is a credible way to increase upper limb rehabilitation intensity in acute stroke care while remaining acceptable to clinical staff. In this setting, *Resynk* generated substantially higher repetition counts than conventional occupational therapy, was positively received by patients, and was judged usable and safe by therapists. The next step is not to ask whether VR should replace hands-on therapy, but how services can combine both approaches to deliver more intensive, motivating, and scalable rehabilitation.

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