IMPLEMENTATION VIRTUAL REALITY-ASSISTED REHABILITATION IN AN OLDER ADULT WITH LUNG ADENOCARSINOMA

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ABSTRACT

Background: Virtual reality (VR) is increasingly used as a rehabilitation, particularly among older adults. VR technology may enhance patient engagement and serve as an adjunctive therapy to conventional rehabilitation with promising outcome. This case report evaluates an older patient's acceptance of VR-based training during hospitalization and assesses changes in clinical status, functional capacity, frailty, quality of life, and sarcopenia risk.
Case Illustration: A 62-year-old man with lung adenocarcinoma completed five sessions of early mobilization using the VR Daily Activity for Ageing & Dementia (VRAGMENT), with a mean duration of 175.8 seconds. During initial session, the patient experienced difficulties with visual adaptation and motor coordination while using the VR. Improvements were observed in the SARC-F score, which decreased by 1 point, the Barthel Index increased by 4 points, and the FI-40 score decreased by 0.1375. The EQ-5D-5L health-state profile also changed from 43334 to 22212. Responses to the Technology Acceptance Model (TAM) questionnaire indicated that the patient found VR enjoyable, easy to learn, and useful. No clinical complaints were reported during VR use.
Conclusion: VR represents an innovation adjuctive therapy with favourable outcomes in hospitalized older adult, including improved functional status and quality of life, reduced frailty, and sarcopenia risk. VR may represent a promising adjunctive rehabilitation modality for hospitalized older adults. Although introducing new technology may present considerable challenges, VR-based interventions appear promising for the older population.
Keywords: virtual reality; older adult; hospitalization; rehabilitation; frailty

ABSTRAK

Latar Belakang: Virtual Reality (VR) di bidang kesehatan digunakan dalam proses rehabilitasi, khususnya bagi lanjut usia (lansia). Teknologi VR mendorong partisipasi pasien dan berperan sebagai terapi ajuvan dengan luaran yang menjanjikan. Laporan kasus ini mengevaluasi tingkat penerimaan pasien lansia terhadap program latihan VR di rawat inap serta menilai perubahan klinis, kapasitas fungsional, derajat kerapuhan, kualitas hidup, dan risiko sarkopenia pada pasien lansia.
Ilustrasi Kasus: Laki-laki, 62 tahun, dengan adenokarsinoma paru menjalani program latihan mobilisasi dini menggunakan game VR Daily Activity for Ageing & Dementia (VRAGMENT) berbasis VR. Intervensi dilakukan sebanyak 5 sesi. Durasi rata-rata 175,8 detik tiap sesi. Pada sesi awal menggunakan VR, pasien mengalami hambatan penyesuaian visual dan koordinasi gerakan. Terdapat perbaikan nilai SARC-F menurun 1 poin, peningkatan nilai Indeks Barthel 4 poin, serta FI-40 menurun 0.1375, serta EQ-5D-5L dari 43334 menjadi 22212. Hasil penilaian menggunakan Technology Acceptance Model (TAM), pasien memperoleh pengalaman positif saat bermain VR; pasien menganggap VR menyenangkan, bermanfaat dan mudah dipelajari; dan tidak ditemukan keluhan klinis selama bermain VR.
Kesimpulan: Penggunaan teknologi VR merupakan inovasi medis sebagai terapi ajuvan pada pasien lansia yang menjalani rawat inap dengan luaran yang baik, meliputi peningkatan fungsional, kualitas hidup, penurunan nilai kerapuhan dan risiko sarcopenia pada pasien. Dampak positif permainan VR pada lansia cukup menjanjikan, walaupun terdapat tantangan yang besar dalam pengenalan teknologi baru tersebut.
Kata kunci: Virtual reality; lansia; rawat inap; rehabilitasi; kerapuhan

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INTRODUCTION

Older adults may experience various challenges during hospitalization, including reduced mobility, discomfort, anxiety, and other conditions that may interfere with recovery. These problems may contribute to functional decline and reduced independence, particularly in older patients who are vulnerable to the effects of hospitalization. Therefore, supportive approaches that can improve patient engagement during rehabilitation may be beneficial in this population.

As technology continues to advance, the implementation of virtual Reality (VR) in healthcare offers extensive opportunities for rehabilitation, particularly among the growing older adult population.[1,2] Virtual Reality console provides a three-dimensional virtual environment that stimulates multiple sensory modalities and may allow hospitalized older adults to interact with therapeutic activities in an engaging manner.[3] The use of VR has been reported to be enjoyable for older adults and may provide favorable outcomes.[1,4] Several therapeutic applications have also been described, including distraction from pain or uncomfortable medical procedures, relaxation and mindfulness for stress and symptom relief, cognitive psychotherapy, and neuromotor rehabilitation.[3] However, the use of VR in older adults may also be associated with potential challenges such as cybersickness, dizziness, nausea, disorientation, and risk of falls, which should be considered during its implementation.

This case report describes the implementation of VR-based exercise in an older adult admitted to an acute care ward. Specifically, it aims to describe the patient's acceptance of VR-based exercise, evaluate its feasibility and tolerability during hospitalization, and report the clinical, functional, frailty, quality of life outcomes observed at discharge.

CASE REPORT

A 62-year-old man presented to the emergency department with dyspnoea that worsened abruptly over the preceding day. A non productive cough of about seven months duration and two weeks bilateral leg swelling and abdominal distension without fever. The examination showed diminished breath sounds over the right hemithorax to the fourth intercostal space, firm nodular hepatomegaly, positive shifting dullness, and bilateral pitting oedema. Admission leukocytes were 11.01 × $10^3/\mu L$, with anaemia, hyponatraemia, and hypoalbuminaemia.

The patient had recurrent right pleural effusion requiring repeated thoracocentesis. The later fluid analysis suggested a malignant effusion, although cytology remained inconclusive, showing atypical cells suspicious for malignancy. Acid-fast and Gram stains were negative, whereas carcinoembryonic antigen (CEA) and Cyfra 21-1 were elevated. Clinical and radiological findings supported pleural involvement, and the effusion was managed as a suspected malignant pleural effusion. Chest radiography showed bilateral effusions predominantly on the right, right upper-to-mid zone consolidation, and a lytic–sclerotic fifth-rib lesion. Contrast-enhanced thoracoabdominal computed tomography demonstrated a massive right effusion with compressive atelectasis and diffuse pleural thickening, a central right lower lobe mass with satellite nodules, nodular pleural thickening suspicious for seeding, and multiple rim-enhancing hepatic lesions with ascites. A multidisciplinary team concluded that CT-guided transthoracic biopsy would be technically challenging because of the central location of the mass and the associated massive pleural effusion. Histopathological examination of hepatic biopsy revealed moderately to poorly differentiated adenocarcinoma. Immunohistochemical staining was positive for TTF-1 and Napsin A and negative for calretinin, supporting the diagnosis of metastatic pulmonary adenocarcinoma, a subtype of non-small-cell lung cancer.

Comprehensive geriatric assessment demonstrated moderate functional dependence as indicated by a Barthel index score of 14/20, frailty with score of 3/5, and positive screening for sacrcopenia with SARC-F score 5/10. Accordingly, the patient received multidisciplinary management integrating medical treatment and conventional rehabilitation, supplemented by VR-based rehabilitation as an adjunctive intervention throughout hospitalization. The conventional rehabilitation program comprised early mobilization, diaphragmatic breathing exercises, airway-clearance techniques, ankle-pumping exercises, and progressive resistance training. As an adjunct to conventional rehabilitation, the patient completed five training session using the VR *Daily Activity for Ageing and Dementia* (VRAGMENT) program delivered through a Meta Quest 2 device.

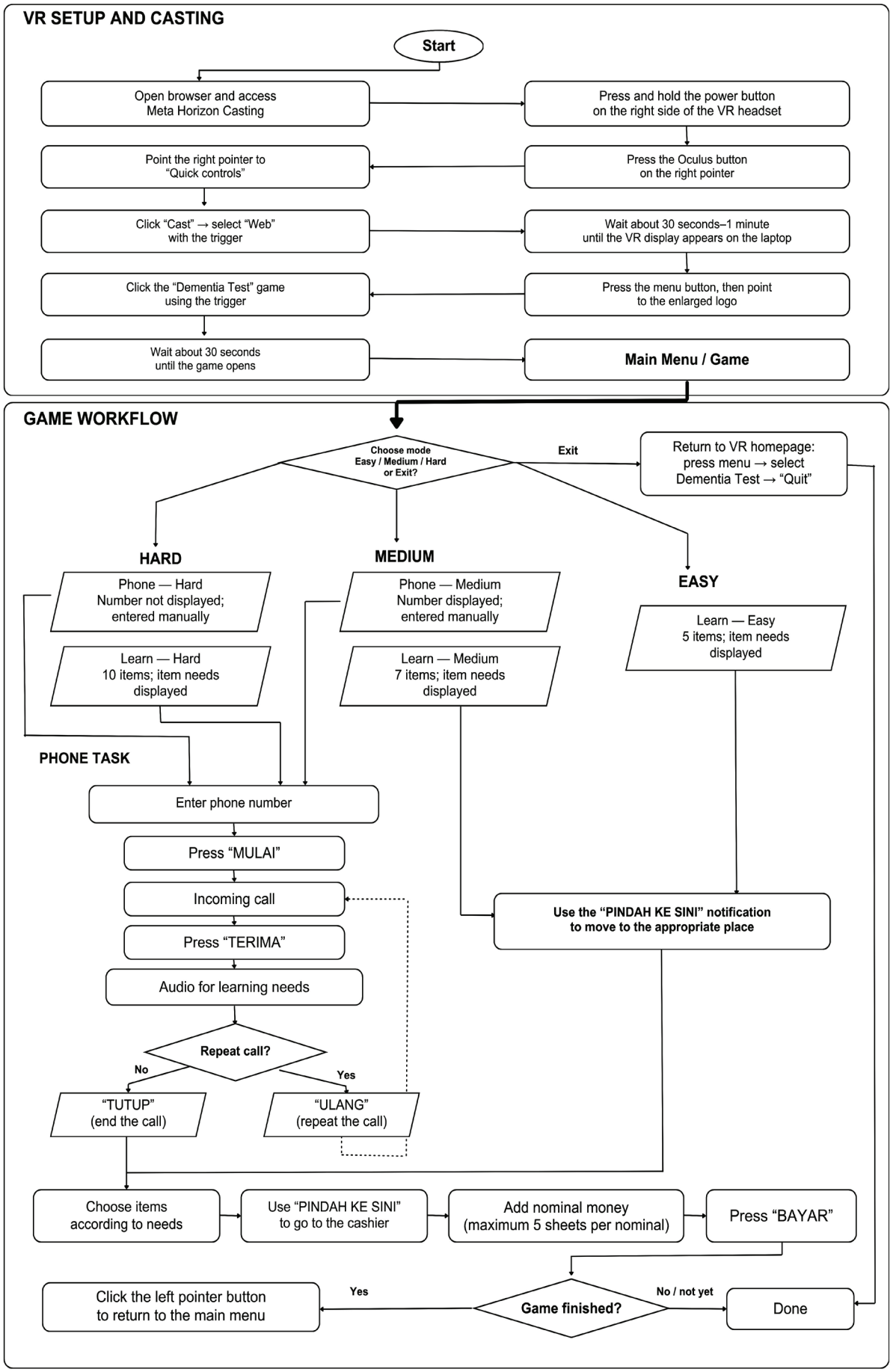


Figure 1. Operational workflow of the VRAGMENT application, from device setup and task selection to activity completion

The mean duration was 175.8 seconds per session. During the initial sessions, the patient experienced difficulties with visual adaptation and motor coordination; however, these difficulties progressively improved over subsequent sessions.
In addition, improvements were observed in the Barthel Index (Δ +4), EQ-5D-5L (from 43334 to 22212), SARC-F (Δ −1), and FI-40 (Δ −0.1375). On the TAM questionnaire, the patient rated the VR intervention as enjoyable, easy to learn, and beneficial; no VR related complaints precluding continuation of the intervention were documented.

Virtual Reality Intervention

The VR program used in this study was the VRAGMENT application. Figure 1 illustrates its operational workflow, including device set up, task and difficulty selection, simulated telephone and shopping activities, payment, and task completion. The position while the patient uses VR is illustrated in Figure 2, the patient is using a headset and is seated in a stable position, both hands holding the VR controller.



Figure 2. Patient positioning during virtual reality–based therapy (AI-generated)

DISCUSION

This case illustrates a medically complex hospitalized older adult who presented with worsening dyspnoea and reduced physical capacity. diagnosed with lung adenocarcinoma, with recurrent pleural effusion and liver metastases. Lung cancer carries a substantial symptom burden, including dyspnoea, cough, pain, and fatigue. These symptoms, particularly breathlessness, can reduce physical capacity, resulting in lower exercise tolerance, more effortful mobility, and difficulty with self-care and activities of daily living, while prompting patients to reduce or discontinue physical activity and thereby contributing to functional limitation and poorer health-related quality of life.[5] Pleural fluid accumulation may compromise respiratory muscle function by reducing available lung volume and restricting ipsilateral-
ventilation and gas exchange, thereby contributing to breathlessness.[6] symptom-driven activity restriction and physiological decline. Breathlessness discourages exertion; reduced exertion, particularly during hospitalisation, accelerates deconditioning and loss of muscle strength, and diminished strength raises the effort demanded by any given task, so that a contracted activity repertoire becomes self-sustaining.
Hospital-associated disability is a well-characterised expression of this sequence in older adults, in whom new dependency in activities of daily living frequently emerges during admission and often persists after discharge.[7] Frailty is common in this population; a systematic review and meta-analysis reported a high prevalence of frailty and pre-frailty among patients with lung cancer, along with associations with adverse clinical outcomes.[8] A recurrent effusion generates breathlessness and restricts activity, promoting deconditioning. In combination with poor nutritional intake and cancer-related muscle metabolic disturbance, this contributes to impaired muscle function, functional dependency, and ultimately, deficit accumulation. A comprehensive approach and integrated management should be carried out to overcome this problem across clinical, functional, frailty, and quality of life.[1] In this case, as an adjunct to conventional rehabilitation, the patient underwent five sessions of *VR Daily Activity for Ageing & Dementia* (VRAGMENT).

In this patient, VR was added to early mobilization, resistance exercise, diaphragmatic breathing, and airway-clearance techniques through repetitive upper-limb and trunk movement during gameplay, which, when coordinated with breathing exercises, may recruit respiratory and postural muscles and promote thoracic mobility. VR-based interventions can also support improvements in neural activation, and motor coordination.[9]

The baseline instruments in this patient: moderate dependence (Barthel Index 14/20), frail (FRAIL scale 3/5), at the threshold at which three or more components define frailty; Morley et al., 2012), and possible sarcopenia (SARC-F score 5/10). The FI-40 change of −0.1375 is an absolute reduction of 0.1375 on the 0 to 1 frailty index scale; which exceeds published anchor-based thresholds for small (0.028–0.030) and large (0.067–0.076) clinically meaningful change in frailty indices.[11] In hospitalized older adults with acute respiratory illness, a 0.03 FI change best identified a one-level change in the Clinical Frailty Scale.[12] The FI-40 reduction is a clinically relevant signal consistent with recovery, not proof of a VR treatment effect. The EQ-5D-5L change from 43334 to 22212 indicates fewer reported problems in all five domains: mobility, self-care, usual activities, pain or discomfort, and anxiety or depression.[13] Improved EQ-5D-5L may be interpreted as a patient-reported indicator of concurrent recovery and increased participation.

At discharge, the patient demonstrated clinical improvement by reduced dyspnea, successful oxygen weaning and concurrent improvements across clinical functional capacity, quality of life outcomes, lower frailty and sarcopenia risk. These changes occurred during multidisciplinary care in which VR was one of several adjunctive therapies. VR was feasible, acceptable, and well tolerated despite frailty, dyspnea, and advanced malignancy. Immersive VR is generally well tolerated in older adults,[14] while meta-analytic evidence suggests potential benefits in cancer rehabilitation.[15]

Limitations of this report include its single-case design, the absence of a comparator, the concurrent use of conventional rehabilitation, and the possibility of natural recovery and regression to the mean. Nevertheless, this case illustrates pragmatic interdisciplinary management incorporating VR in a patient with substantial respiratory and oncological complexity. Improvements were observed in clinical status, functional capacity, quality of life, frailty, and sarcopenia risk. These findings suggest that VR was well tolerated and may serve as a promising adjunctive therapy associated with favorable clinical outcomes

CONCLUSION

In this hospitalized elderly patient with lung cancer, VR-based exercise as an adjunctive rehabilitation intervention was feasible, well tolerated, and positively received. Upon discharge, improvements were noted in clinical status, functional capacity, frailty, sarcopenia risk, and quality of life. These findings suggest VR is a promising adjunct to rehabilitation, though controlled trials are required to confirm its efficacy.

Ethics and Consent

This study was approved by the Medical Research Ethics Committee of Universitas Indonesia (KET-261/UN2.F1/ETIK/PPM.00.02/2024). Written informed consent was obtained from participant or their legally authorized representatives before enrolment.

Conflict Of Interest

The researchers claim no conflicts of interest.

AI Declaration

Generative AI was used solely to create the patient-positioning illustration.

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Author Contributions

M.W.: formal analysis, investigation, data curation, writing original draft, writing review and editing, visualization, and project administration. M.H.: conceptualization, methodology, validation, formal analysis, investigation, resources, data curation, writing review and editing, visualization, supervision, project administration, and funding acquisition. S.W.: methodology, validation, formal analysis, investigation, resources, data curation, writing original draft, writing review and editing, visualization, supervision, project administration, and funding acquisition. H.Y.: writing original draft, writing review and editing, and visualization. F.A.T.: writing original draft, writing review and editing, visualization, and project administration. N.A., J.E.S., and N.A.F.: methodology, writing review and editing, and visualization.

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