Usage of immersive virtual reality as a relaxation method in an intensive care unit *

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Abstract

Introduction: The usage of immersive virtual reality (iVR) in the context of an intensive care unit (ICU) is scarce. Our objective was to assess the feasibility of the usage of iVR in critical patients with or without mechanical ventilation (MV) and to determine the anxiety degree before and after each session.

Methods: Analytical, descriptive, prospective, and cross-sectional research. Pilot test with 20 patients from a polyvalent ICU of a tertiary hospital. Adult patients were included, either connected or not to MV, watchful and calmed (RASS −1/+1) and without delirium (negative CAM-ICU). Oculus Go (Facebook Technologies, LLC) iVR glasses were the model used. The relaxation strategy consisted in the visualization of an experience of 15 minutes with scenes related to nature and fantasy, relaxing music with a plot. The sessions were individual, with the patient monitored in a fowler position or seated. The anxiety degree before and after each session was evaluated following a reduced version of the Spanish ''Cuestionario de Ansiedad Estado-Rasgo (STAI-e)'' and they were analysed using T samples coupled (statistical significance when p-value was <.05).

Results: Incorporation of 20 patients with an average age of 63.9 years old (60% men). A total of 34 sessions of iVR were conducted. The 32% patients mechanically ventilated, 32% high-flow oxygen therapy, 36% other breathing supports. 80% of the sessions were completed without serious side effects. A significant

decrease in the anxiety degree was observed after each iVR session: first session mean change −2.68 (SD = 2.75), p<.001; second session mean change −1.86 (SD = 1.57), P=.021; third session mean change −1.67 (SD = 1.63), P=.054.

Conclusion: The usage of iVR in the context of an ICU is feasible, even with patients mechanically ventilated. iVR reduces the anxiety degree in the critic patient, which suggests that ''digital therapies'' can be effective to improve the emotional state during their stay in the ICU.

KEYWORDS: Virtual reality; Non-pharmacological therapies; Intensive care unit; Critical care

What is known/what does it contribute?

The use of immersive virtual reality (iVR) in the context of an Intensive Care Unit (ICU) is not common. Applying iVR as a digital therapy in ICU patients is an innovative approach. This work demonstrates that iVR is feasible, even in mechanically ventilated patients. Moreover, it can be an innovative solution to address the anxiety of the ICU patient.

Implications of the study

A stay in an ICU ward can be very stressful for the patient. The use of iVR can have benefits for the patient by meeting their need for reassurance and wellbeing, helping to reduce anxiety and stress.

This patient-centred experience enables the patient to benefit from virtual reality technology in the hospital setting and is an innovative experience. It is a non-invasive, easy-to-use technique that enables the patient to interact with the virtual environment wearing goggles at the bedside, with little or no assistance. Based on this study, it is possible to further develop the application of iVR with objectives that improve the clinical evolution of the critical patient.

Introduction

Patients admitted to an Intensive Care Unit (ICU) have a prolonged average length of stay [1] and at the same time this can be a traumatic experience. In fact, in the literature, post-intensive care syndrome is defined as the following [2] which describes cognitive, psychological, physical and other consequences that affect between

50-75% of ICU survivors. [3,4] Anxiety stands out as one of the most negative experiences for ICU patients. [5,6] Immersive virtual reality (iVR) technology is currently being used as a relaxing, distracting experience in a variety of clinical situations. In surgical settings, iVR is being demonstrated as an adjunct to reduce intraoperative or postoperative pain and anxiety for multiple types of procedures in adults and children. [7-9]

Our aim was to evaluate the feasibility of applying the use of iVR in ICU patients with or without MV by means of a pilot test. We also aimed to determine the degree of anxiety before and after the iVR session and the degree of patient satisfaction with the iVR experience.

Material and method

This is a descriptive, prospective, cross-sectional, analytical, descriptive pilot study conducted in a 16-bed multipurpose adult ICU of a referral hospital. Data collection was carried out between July 2019 and July 2020.

Participants were selected by non-probability sampling. The pilot study was conducted with 20 patients. The study by Turon et al. [8] presents satisfactory results with 20 participants in their feasibility and safety study of virtual reality-based neurocognitive stimulation in critically ill patients.

The study population included patients who met the following inclusion criteria: men and women over 18 years of age; patients with or without endotracheal tube (ETT) or tracheostomy, connected or not to MV; with a negative score on the CAM-ICU (*Confusion Assessment Method for Intensive Care Unit*) scale; [10] with a RASS score (*Richmond Agitation- Sedation Scale*) [11] of between -1 and +1, i.e. alert and calm. The following were excluded: unstable patients; patients with a neurological or psychiatric diagnosis on admission; patients with isolation measures for multi-resistant bacteria; patients with facial and/or head injuries that prevented the use of the iVR goggles; and patients with hearing deficits or blindness.

The variables considered were the following:

a) Socio-demographic data and data related to the clinical situation of the patient: age, sex, date of admission to the ICU, reason for admission, type of respiratory support at the time of the ventilation session, CAM-ICU and RASS scales.
b) Related to the viability of iVR:
    a. Duration of each iVR session: maximum 15 min.

b. Number of sessions completed.

c. Number of interruptions during the session and the reason.

c) Related to pre- and post-iVR anxiety: Spielberger's STAI-e (*State-Trait Anxiety Inventory for Adults*) anxiety assessment scale was used in the short version of the STAI scale. This scale consists of 6 items and is validated in Spanish for patients undergoing MV and admitted to the ICU.

d) Related to patient satisfaction with the iVR experience: this consisted of a short ad hoc satisfaction questionnaire and, if desired, patients could express their impressions of their experience with iVR. The questionnaire consisted of four items referring to the qualities of the iVR, and a fifth item on possible benefits or side effects. Each item was answered on a Likert-type rating scale. Finally, an overall rating of the experience was requested on a scale from 0 ''not at all satisfied'' to 10 ''very satisfied''.

In this pilot test, the Oculus Go VR goggles (Facebook Technologies, LLC.) were used. The relaxation strategy consisted of viewing an experience created with motifs of natural scenes and metaphorical and fantasy elements. The experience was entitled ''VR Moments: Immersive Experience for Emotional Wellbeing'', created by the company Humantiks. The visual experience also included auditory stimulation combined with sounds of nature itself (e.g., the sound of the sea, the sound of a waterfall, etc.), relaxing music and binaural sounds, sometimes with some narrative, depending on the visual content. The iVR session took place on the morning shift, after the patient had received nursing care and a medical check-up. The session could coincide with the presence of a family member or companion. The same patient could receive more than one session during their stay in the ICU, if they so wished, with a maximum of 3 sessions, although it was always the same visual experience.

On a daily basis, a member of the research team assessed patients who were eligible for an iVR session. When a patient was selected, a member of the research team was present throughout the session. He or she was responsible for filling in the data in the data collection notebook (DCN). The number of patients who received the iVR session and the number of sessions were completed were recorded. For each session, the time of use of the visual experience by the patient was counted (maximum 15 min). Using the BetterCare® system, the patient's vital signs were recorded: heart rate (HR), mean arterial blood pressure (mBP), respiratory rate (RR)

and peripheral oxygen saturation (O2 sat). These were recorded at three points in time: 10 min before the start of the session, during the session and 10 min after the end of the session.

Statistical analysis

a) Descriptive analysis: for quantitative variables, median and standard deviation or percentiles and the minimum and maximum were used. For qualitative variables, absolute and relative frequencies were used.
b) Feasibility analysis: the percentage of patients refusing iVR and the percentage of sessions refused were calculated. Possible changes in cardio-respiratory parameters were analysed using linear mixed models, with 'patient' as the random term, and time (before the session, during the session and after the session) as the explanatory variable.
c) Analysis of anxiety: by inferential analysis of the items. Analysis of pre-post change with parametric and non-parametric paired data tests according to data normality.
d) Analysis of satisfaction with the experience: descriptive analysis of the satisfaction scale and qualitative analysis of patient responses.

Statistical significance was considered to have been reached when the p-value was <0.05.

SPSS version 25 was used for data processing and analysis.

Ethical aspects

The study was approved by the hospital's Research Ethics Committee (Approval number: 2019/573).

It was considered necessary to obtain informed consent from the patient and, if required by the patient, in the presence of a family member.

The confidentiality of the data and the maintenance of anonymity of all participants was guaranteed by pseudoanonymisation. The research group were the only persons collecting the data and were responsible for safeguarding the data at all times.

Results

Sociodemographic and clinical data on participants

Twenty patients were included, with a mean age of 64 years and 60% were male. The main medical diagnosis on admission was acute respiratory failure. Table 1 shows the descriptive analysis of the socio-demographic data.

All patients underwent at least one session of iVR. Of the 20 participants, 8 wanted to repeat the iVR session a second time and 6 a third time, although no two sessions were ever performed on the same day. Thus, a total of 34 iVR sessions were run during the study period.

At the time of the iVR session, all patients included were alert and calm (RASS between -1 and +1), and none had delirium (negative CAM-ICU).

It should be noted that almost one third of the sessions were run with the patient connected to MV and the majority with a high-flow nasal cannula (HFNC). Fig. 1 shows a breakdown of the different types of ventilatory support used at the time of the VR session.

Feasibility of iVR

Twenty-six/34 (76.5%) 15-minute sessions of iVR were completed. The reasons for discontinuing sessions before completion were basically of two types: either technical or subjective reasons for the experience. These are detailed in Table 2.

Using the BetterCare® system, the patient's vital signs were recorded at three points in time: before the start, during and after the session. No out-of-range values or significant variability of vital signs were observed.

No adverse events related to accidental detachment of catheters or endotracheal tubes were detected.

Anxiety

Assessing anxiety before and after each iVR session with the STAI-e scale, 32 (32/34, 94%) fully completed questionnaires were obtained. Anxiety before and after each iVR session was compared and analysed by paired sample t-test. In Table 3, a statistically significant decrease in anxiety level can be seen after the first and second session of iVR. In patients who repeated the experience a third time, it appears that anxiety also decreased, but not significantly.

Patient satisfaction

A total of 17 questionnaires were completed (17/20, 85%), with entertainment and session duration scoring well. On the other hand, the quality that iVR can offer such as the feeling of immersion, i.e., the feeling of being inside the visual experience, scored somewhat lower.

The comfort of the device (Oculus Go) got very good scores.

Regarding side effects, only 2/17 (11.8%) reported ever experiencing dizziness or drowsiness during the iVR session. The experience reported very good results in terms of achieving a sense of calm and well-being during the session.

Overall satisfaction with the experience was rated an average of 8.4 on a scale of 0-10. Table 4 describes each of the scores for the questionnaire on satisfaction.

Discussion

This pilot study demonstrates the feasibility of applying iVR in ICU patients with or without MV. Furthermore, statistically significant results were obtained for decreasing the level of post-intervention anxiety. Patients were satisfied with the experience and iVR was able to bring them peace of mind and well-being in an ICU setting.

Regarding iVR and patients connected to MV, in the scientific literature we found, the authors do not describe any adverse effects such as obstruction or accidental removal of catheters or tubes in this context. [7] Turon et al., [8] also reported no adverse effects of this type when applying VR to their 20 patients with or without MV. In our pilot study, no adverse effects were reported, regardless of the ventilatory support device used. Other authors, such as Ong et al., [12] who applied iVR to non-MV patients in the surgical and trauma ICU, reported no such complications.

In the sample studied, there were no out-of-range values and no adverse events related to accidental detachment of catheters or endotracheal tubes were detected.

iVR is feasible and easy to manage for ICU patients and is compatible with various different ventilatory conditions. In agreement with Gerber et al., [13] the advantage of this tool is that it enables the patient to interact with a virtual environment using goggles, without leaving the hospital bed and with little or no help from another person.

Indeed, distraction is a common non-pharmacological technique used by healthcare professionals to control and attenuate anxiety, and possibly pain, during clinical procedures. [14] In fact, iVR may offer even more distraction, as it completely immerses the patient in another world and engages multiple senses. [15] Concerning

the anxiety that patients admitted to an ICU may present, Perpiñá-Galvañ and Richart-Martínez. [5] published a review analysing different scales and levels of anxiety perceived by these patients. In this review, between 25% and 80% of patients admitted to the ICU presented moderate to severe levels of anxiety.

For this study, it was considered appropriate to use the STAI-e scale [16] to estimate the level of patients' self-perceived anxiety. Our results confirmed the success of iVR in decreasing the level of anxiety in patients admitted to an ICU. A statistically significant decrease in anxiety level was observed after the first and second session of iVR. However, in patients who repeated a third time, the level of anxiety also decreased but not significantly. This may be due to the fact that the visual experience was always the same and, consequently, the persuasiveness of the patient's attention decreased. This result is similar to that obtained by Ong et al., [12] who also always used the same visual experience, although in their group they estimated anxiety using the *Hospital Anxiety and Depression Scale* (HADS). [17] There were statistically significant decreases in anxiety and depression from before the first exposure to before the third exposure to iVR. In a setting such as an ICU, where the patient is exposed to cognitive, psychological and physical consequences [4] further evaluation of the anxiolytic effect of iVR therapy would appear to be appropriate.

Patients responded satisfactorily to the iVR experience. Regarding the comfort of the goggles, they were well tolerated despite their apparent size and weight (468 g). The majority of respondents said that the visual content was entertaining and that the duration of the experience was adequate. What scored most poorly was the sense of immersion that iVR could offer. VR immersion or ''presence'' is a subjective illusion created in the user's mind based on sensory information from the VR headset/device and the VR software. The enhancement of VR immersion plays an important role in influencing the distraction and also the analgesic effect on the participant, for example, as stated by some authors. [9]

One of the essential elements of virtual reality is therefore virtual content, and for patients admitted to the ICU, selecting an appropriate virtual scenario is critical: virtual reality environments must be carefully designed to minimise sensory conflicts. [13] As a consequence, side effects of the cyberspace or virtual environment created may occur, and if these are to be minimised, the virtual content must be chosen or designed well.

In the systematic review by Smith et al., [18] 50% of the content was an active form of VR, which involved an element of interaction with the virtual environment on the part of the inpatient. In contrast, the remainder were given a passive form of iVR, where patients could only observe the content. In our study, in order to test the

feasibility in critically ill patients, we opted for a passive VR relaxation strategy, preferring exposure to natural environments as the virtual setting. Gerber et al., [13] who also used natural scenes for their study in healthy participants in a simulated ICU, also obtained a relaxing effect with exposure to nature scenes.

In this study, only one patient reported some dizziness, and one reported drowsiness. There were no cases of nausea, vertigo, visual fatigue, headache, or other unwanted symptoms related to iVR. In the study by Mosso-Vazquez et al., [19] study, only three (3/67) post-operative cardiac surgery patients, conscious and not intubated, showed signs of nausea and vertigo when using iVR. Similarly, Smith et al., [18] found that, overall, the prevalence of side effects was low, ranging from 0% to 8% of the studies in the review.

Limitations of the study

Our sample is small and data was collected from only one centre, so the extrapolation of our results is limited. However, this study is one of the first to establish proof of concept, with the aim of testing the feasibility of iVR in critically ill patients.

Regarding anxiety, the effect of iVR could only be seen immediately after the experience, however it remains to be determined whether or not the effect is sustained over time.

Our study did not include assessment of the patient's pain. The assessment of pain using a validated scale for its subsequent classification would enable us to have a more complete global assessment at a sensory or emotional level.

Sometimes patients received suboptimal iVR experiences due to equipment errors (e.g., spent battery). Technical and procedural difficulties can contribute to participant frustration and should be minimised with good preparation to provide the best possible experience.

Conclusions

Distraction is a common non-pharmacological technique used by healthcare professionals to manage and mitigate anxiety, and possibly pain, during clinical procedures. In fact, VR may offer even more distraction, as it completely immerses the patient in another world and engages multiple senses.

There is a need to reflect on passive or the active VR that could be offered to critically ill patients and to conduct research on which virtual environments are most appropriate and what is the optimal duration to achieve benefits for critically ill patients.

In this study, we conclude that the use of iVR is feasible in the ICU setting, even in mechanically ventilated patients. The use of iVR reduces anxiety in critically ill patients, suggesting that this ‘‘digital therapy’’ may be effective in improving the feeling of wellbeing during the stay in ICU.

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Conflict of interest

The authors declare that they have no conflicts of interest.

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Table 1 Characteristics and diagnosis of participants (n = 20).

Age [mean ± standard deviation]	64 ± 13
Sex	[n, (%)]
Men	12 (60)
Women	8 (40)
Main diagnosis	[n, (%)]
Acute respiratory failure	9 (45)
Septic shock	5 (25)
Haemorrhagic shock	4 (20)
Polytrauma	2 (10)

Table 2 Reasons for discontinuing the iVR session (n = 34).

Technical reasons	[n, (%)]
Fogging of the visor	2 (5,9)
Spent viewfinder battery	1 (2,9)
Subjective reasons	**[n, (%)]**
Expressed discomfort	2 (5,9)
Manifested drowsiness	1 (2,9)
Expressed unwillingness to continue	2 (2,9)

Table 3 Statistical significance of 'anxiety' after the iVR session (n = 32).

STAI-e Scale	n	half	Sig.
S1_PRE and S1_POST	19	−2.68 points	0,000
S2_PRE and S2_POST	7	−1.86 points	0,021
S3_PRE and S3_POST	6	−1.67 points	0,054

S1: first session; S2: second session; S3: third session.PRE: before the session; POST: after the

Table 4 Satisfaction questionnaire scores (n = 17).

Item	Score [n, (%)]				
	Never	Rarely	Sometimes	Most of the time	Always
Entertainment	1 (5.9)	1 (5.9)	2 (11.8)	2 (11.8)	11 (64.7)
Immersion	2 (11.8)	2 (11.8)	4 (23.5)	4 (23.5)	5 (29.4)
Duration	0	3 (17.65)	1 (5.9)	2 (11.8)	11 (64.7)
Goggle comfort	0	0	1 (5.9)	2 (11.8)	14 (82.4)
Side effects					
Nausea	0	0	0	0	0
Dizziness	0	0	1 (5.9)	0	0
Drowsiness	0	0	0	0	1 (5.9)
Headache	0	0	0	0	0
Peace of mind	0	1 (5.9)	2 (11.8)	4 (23.5)	10 (58.8)
Well-being	0	1 (5.9)	0	6 (35.3)	10 (58.8)

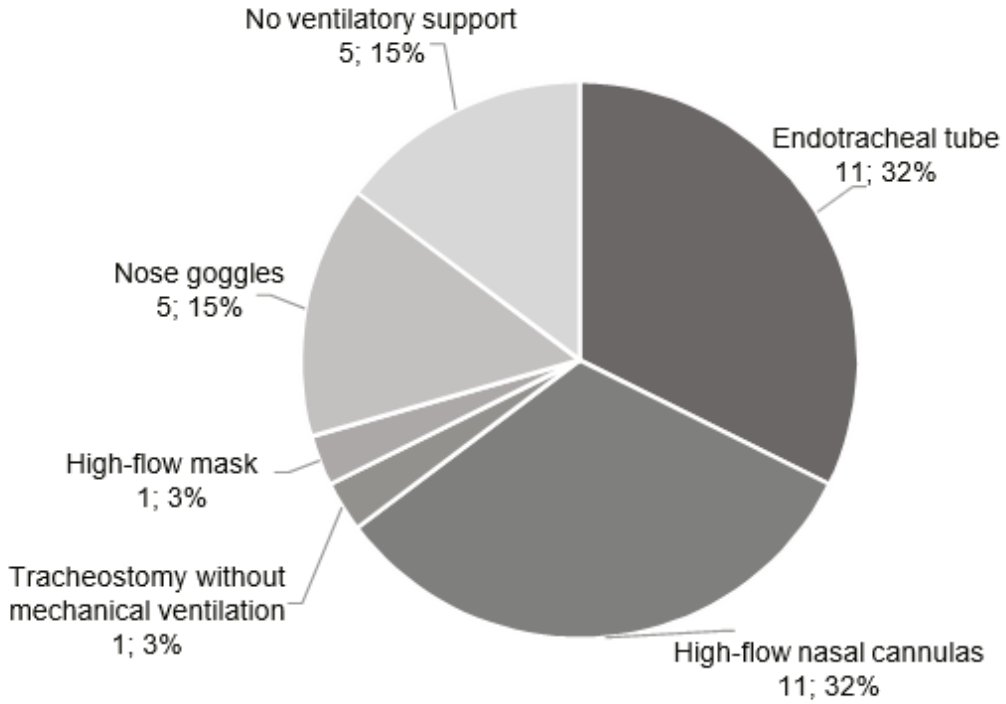

Figure 1 Type of ventilatory support in iVR sessions.