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Research Article

Virtual Reality Goggles as an Arsenal to Reduce ICU Delirium-Prospective Observational Study

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Abstract

Introduction: ICU delirium is a serious condition that results in an acute change in the mental state of critically ill patients, with disturbances to their consciousness, attention, cognition and perception. It can lead to increased lengths of stay, poor clinical outcomes, increased costs and residual psychological sequelae. We hypothesize that virtual reality (VR) may provide an ideal platform for controlled, scalable, and effective environmental manipulation in the ICU.

Aim and Objective: To study the effectiveness of VR goggles in the reduction of ICU delirium.

Materials and Methods: The OCULUS VR system was used in this study. The VR system consisted of the Oculus Go VR headset with a hand-held controller. In addition to the VR headset, patients were provided with earphones to provide the audio for the VR experience and reduce environmental noise. Both the headset and the earphones were affixed with protective sanitary covers. The CAM ICU score 7 was used to assess the delirium.The effectiveness of VR goggles to reduce the ICU delirium was evaluated during the subsequent 4 days.

Results: Fifty patients admitted to the icu were divided into two groups, one group had goggles (VR) and other the standard treatment group (CR).

The difference in mean CAM 7 scores was not statistically significant though higher in VR compared to CR on day 0 (5.0 ± 0.87 > 4.9 ± 0.95), same in both VR and CR on day 1 (4.4 ± 0.91 = 4.4 ± 0.86), slightly higher in VR compared to CR on day 2 (4.0 ± 1.00 > 3.9 ± 0.76) and lesser in VR compared to CR (3.4 ± 0.99 < 3.8 ± 0.97) on day 3. But on day 4, mean CAM 7 scores of VR (2.5 ± 1.01) was significantly lower than controls (3.3 ± 1.34) which was statistically significant ($p < 0.05$). The decrease in CAM 7 scores from day 0 to day 4 is more in VR (2.5 ± 01) compared to CR (1.6 ± 1.60), and the difference in decrease between VR and CR were statistically significant ($p < 0.05$).

Conclusion: The virtual reality goggles can be used as a simplest non pharmacological method to reduce the incidence of ICU delirium.

Keywords: *Arsenal; ICU Delirium; Virtual Reality (VR)*

Introduction

Delirium is one of the most common predicaments that an intensivist can encounter in day in and day out of critical care practice. The prevalence rates [1] ranging from 32.3 - 77% and the incidence rates from 45 - 87% are noted with regards to delirium in ICUs [2].

Early diagnosis and monitoring is very gruelling, as the tools and methods available are limited and subjective. Disturbance in circadian rhythms, sedation or substance abuse, severe infections, age related factors can precipitate delirium in ICU.

ICU delirium is defined as an acute change in the mental state of critically ill patients with disturbances to their consciousness, attention, cognition and perception [3]. Diagnosis of ICU delirium is dependent on changes in one's cognition, activity and orientation during ICU stay. The incidence of ICU delirium among critically ill patients is associated with higher mortality and morbidity, ICU delirium prolongs hospital stay, increases costs and worsens the outcome. Delirium in ICU is independently associated with short-term cognitive functions and long term PTSD symptoms.

Delirium in ICU requires as much attention as other organ failures because it is independently associated with prolonged ICU stay, increased cost of treatment, higher mortality, and long-term cognitive decline [4].

There are number of factors which can lead to this complication, including increased age, severe comorbid conditions, criticality of illness, severe sepsis due to infections, cancer therapy, electrolyte and endocrine disturbances and cerebrovascular, renal and cardiac dysfunction. In addition, withholding of benzodiazepines that could be used for sedation, inadequately relieved pain, alcoholism, smoking and substance abuse can precipitate ICU delirium.

Delirium in ICU may occur as a hypoactive, hyperactive or mixed forms. Many pharmacological and non pharmacological strategies have been practiced for prevention and treatment of delirium in ICU. Despite non pharmacological strategies lacking clinical evidence of their efficacy in a clinical setting, such as early mobilization, sleep improvement and re-orientation, there is no harm and didn't evoke any negative reactions and is thus safe to use.

Virtual Reality (VR) stimulation may provide ideal platform for controlled, scalable and effective environmental manipulation in the ICU and helps in reduction of incidence of ICU delirium. OCULUS VR system is one of the best commercially available VR systems in the market and we used it test our hypothesis that VR stimulation may decrease the incidence and reduce the severity of delirium in ICU patients when used with proper precautions.

Materials and Methods

This prospective observational study was conducted under the supervision of the institutional ethical committee in an Indian ICU. After explaining the study, and informed, written consent was taken from all the ICU patients or their near ones who fulfilled the inclusion criteria, for using VR stimulation system to conduct the study.

Patients were considered as eligible for inclusion into the study if they were of age group between 18 and 65 yrs and admitted to ICU with a predicted stay of more than 24 hours. Patients with pre existing psychiatric illness or neurological diseases or with any history of alcoholism and patients who are predicted to have stay less than 24 hours in ICU were excluded from the study.

Procedure

All patients fulfilling the inclusion criteria were subjected to the application of OCULUS VR system. The VR system consists of the Oculus Go VR headset with a handheld remote controller and noise canceling earphones. The intervention i.e. application of VR stimulation is started after obtaining informed consent. As stimulation material we used immersive 360° videos like nature, forests, urban parks etc. for a period of 10 - 15 minutes per session, and two sessions a day, one in the morning and the other in the evening until the day patient was discharged or shifted from ICU. A new video was shown each day and the same location at different time points was shown in the same day. So that the patient can get oriented to time. The intervention group and control group both received the standard ICU care both pharmacological and non pharmacological. The ICU CAM 7 score was used to assess the mental status of the patient daily and tabulated at the same time every day.

Statistical analysis

Data was entered into Microsoft Excel and analyzed using IBM statistical package for social science (SPSS) version 21. Quantitative variables were expressed in mean and standard deviation. The association between the cases and controls were tested using unpaired t-test for inter group comparisons. Logistic regression analysis was done to understand the overall effect of each variable on outcome. P value less than 0.05 was considered as having significant difference between groups.

Results

Fifty patients admitted to the icu were divided into two groups, 25 patients in One group had goggles (VR) and other 25 patients in the standard treatment group (CR).

The mean age of the VR group was 52.3 ± 17.28 years and CR group was 51.4 ± 14.89 years and this difference is not significant statistically. Mean APACHE II scores were slightly more for CR group (12.8 ± 4.97) compared to VR group (10.5 ± 4.91), but the difference is not significant statistically. Similarly, Mean SOFA scores for CR group (3.8 ± 2.33) was more compared to VR group (3.3 ± 2.75), but the difference is not significant statistically. The difference in the mean ICU stay in days was also not significant between VR group (5.5 ± 2.47 days) and CR group (6.2 ± 2.46 days).

The difference in mean CAM 7 scores was not statistically significant though higher in VR compared to CR on day 0 (5.0 ± 0.87 > 4.9 ± 0.95), same in both VR and CR on day 1 (4.4 ± 0.91 = 4.4 ± 0.86), slightly higher in VR compared to CR on day 2 (4.0 ± 1.00 > 3.9 ± 0.76) and lesser in VR compared to CR (3.4 ± 0.99 < 3.8 ± 0.97) on day 3. But on day 4, mean CAM 7 scores of VR (2.5 ± 1.01) was significantly lower than controls (3.3 ± 1.34) which was statistically significant ($p < 0.05$). The decrease in CAM 7 scores from day 0 to day 4 is more in VR (2.5 ± 01) compared to CR (1.6 ± 1.60), and the difference in decrease between VR and CR were statistically significant ($p < 0.05$).

Discussion

One of the most common complication in a multidisciplinary ICU is the development of Delirium. This Delirium not only increases the morbidity, mortality and prolongation of ICU stay but also can lead to cognitive dysfunction and PTSD symptoms both in short term and long term duration. ICU delirium is characterized by sudden decline in mental status, i.e. cognitive function, attention and orientation of the patient after admission into ICU without any prior or current neurological ailments.

One likely cause for delirium is disturbance to the sleep-wake cycle caused by interrupted sleep and a loss of day/night orientation [5].

To identify it at an early stage and diagnose it, many tools and charts have been developed and put into use.

Delirium Rating Scale-Revised-98 (DRS-R-98) is a widely used delirium severity scale advocated in the ICU setting given its strong psychometric properties [6].

In a systematic review from 2007, six validated instruments to assess delirium in critically ill patients were identified. These included the Cognitive Test for Delirium, abbreviated Cognitive Test for Delirium, Confusion Assessment Method for the Intensive Care Unit (CAM-ICU), Intensive Care Delirium Screening Checklist, Neelon and Champagne Confusion Scale, and the Delirium Detection Score [7]. Another instrument to detect delirium is the Nursing Delirium Screening Scale, of which the validity and reliability were assessed in the ICU [8].

Several biomarkers have been associated with delirium, Serum anticholinergic activity, S100B, brain-derived neurotrophic factor, neuron-specific enolase, interleukins, and cortisol are elevated [9,10].

Among them CAM ICU 7 scoring system stood out as pioneer as it is a valid, reliable and practical delirium severity measure among ICU patients that can be easily calculated and is associated with meaningful clinical outcomes [11].

Despite being proven effective in the literature and practice, the utilization of CAM ICU 7 score still got barriers in implementation at ground level i.e. medical - nursing communication gap, lack of specialized education and training, time management and lack of generalizability are worthy to be noted. But CAM ICU 7 is rapid, easy to administer with minimal training, and can be translated into local languages.

CAM ICU 7 can also be adapted to use for patients with visual and hearing disturbances and can be easily reproducible.

CAM-ICU-7 delirium severity scale showed good test characteristics with a higher predictive validity for in-hospital mortality over delirium severity measured through the DRS-R-98 and over delirium duration [12].

However, CAM ICU 7 tool can't assess or diagnose the subtype of delirium. It also indicates the data only at a certain point of time and its not a continuous measure. Thus, to avoid missing the diagnosis, clinicians should perform assessment multiple times a day and for which the patient cooperation is paramount. To summarize, CAM ICU 7 has got a sensitivity rate of 93% and a specificity of 89% and the inter rater reliability is very high, so with all due precautions and training, we used CAM ICU 7 score as our assessment method for diagnosing ICU delirium and prognosis.

To reinforce our hypothesis that VR stimulation can reduce the incidence of delirium in ICU, we got the brace of the literature suggesting the same. A total of 50 cases were included in the study allocating the cases equally between the control and intervention group through thorough randomization. With application of VR stimulation to the intervention group we not only noticed the calmness in the patient but also there is change in vital signs of the patient but when compared to the control group the change in vital signs is not statistically significant. But the incidence of delirium and change in CAM scores are significant when both groups are compared.

The addition of physical and occupational therapy to daily interruption of sedation leads to shorter duration of delirium and better functional status in ventilated patients [13].

Pharmacological treatment for delirium traditionally includes haloperidol. Second-generation antipsychotics like quetiapine have emerged as an alternative for the treatment of delirium, and they may have a better safety profile [14].

Physical restraints may cause unplanned extubation and worsen delirium and agitation [15].

In 2017, Gerber., *et al*. [16], conducted a study using VR stimulation and found that there is significant change in vital signs of the patient when VR stimulation is applied but no comment was made on incidence and prognosis of delirium. But that study indirectly stated that change in vital signs may indicate the reduction in stress levels in patients when VR stimulation is used which may decrease the incidence of delirium. Chirico., *et al*. and Bolder., *et al*. also noted that exposure to VR stimulation can trigger specific psychophysiological patterns of parasympathetic activation.

In our current study, we noticed a decrease in the incidence of delirium, and the decrease in CAM ICU 7 scores from day 0 to day 4 is significant statistically in cases compared to controls. Similar type of study but in a large scale was started in March 2022 by Neaf., *et al*. and is expected to continue until March 2024 [17].

Our study has got its own limitations such as the small sample size and the results cannot be extrapolated. There is no blinding and the interviewer and the observer all know which patient belongs to which group. Inspite of all the setbacks and limitations with the support of the data even though small, from our study, it can be stated that VR stimulation has the potential to reduce the incidence and severity of delirium if used with proper guidelines. Application of VR stimulation is possible in multidisciplinary ICUs with standard health and hygiene practices. VR stimulation did not evoke any discomfort to the patients and can be used safely.

Conclusion

It is a small observational study done to evaluate the delirium incidence in ICU patients using virtual reality googles. The results indicate that there is a definitive decrease in CAM 7 score which is statistically significant. More number of studies will be able to discern the reduction in mortality and morbidity.

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