Effect of virtual reality experience on distress in children admitted to the intensive care unit: a randomized controlled trial

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Abstract

Introduction: Admission of children to the intensive care unit (ICU) can lead to a decline in age-appropriate behaviour and a rise in distress and anxiety. Virtual reality (VR) is a safe, cost-friendly, effective and acceptable treatment for medical or dental treatment related pain and emotional distress but its effect in decreasing distress in children admitted to the ICU is not well studied.

Objective: To study the effect of VR experience on distress in children admitted to the ICU.

Method: A randomized controlled trial was conducted on 30 children, aged 4-17 years, admitted to paediatric ICU (PICU) with 15 in intervention group and 15 in control group. Intervention group received 7 consecutive days of VR experience lasting 15 minutes. Control group received routine care provided in PICU. Distress was assessed using COMFORT Behaviour scale and anxiety using State Anxiety scale (STAI-CH) pre and post intervention.

Results: Children in the intervention group showed a significant decrease in distress with a mean difference of 4.93 ± 2.12 within the intervention group and 3.20 ± 2.21 within the control group. The p-value was 0.0369 which is statistically significant. In the STAI-CH scores, the mean difference within the intervention group was 11.40 ± 5.58 and control group was 6.73 ± 4.50. The p-value was 0.0001 which is statistically significant.

Conclusions: VR experience intervention is effective in decreasing distress in children admitted to the ICU.

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Introduction

Intensive care units (ICUs) admit thousands of children each year who require critical care. Children in the ICUs have diverse disorders, including acute conditions, injuries, metabolic diseases and complicated congenital deformities[1]. Respiratory illnesses, congenital anomalies, neurological problems, injuries from external sources, neoplasms, endocrine/metabolic diseases, circulatory system disorders and musculoskeletal disorders may be among them[1,2]. Children in the ICU are usually attentive and have normal cognitive abilities but are unable to interact independently with their environment or engage in play or cognitive activities due to constraints[3,4].

When children are admitted to the PICU, they are exposed to a highly variable environment associated with excess stimulation from lights, sounds, and activity created by monitors and ventilators, as well as emergency situations, absence of diurnal variation, constant change of caregivers and discomforting procedures which may be painful such as assisted ventilation and intravenous cannulation[5]. In the PICU, children are usually hooked up to a variety of vital-sign monitoring devices, given intravenous fluids, and confined from moving around freely in their beds[2]. Being exposed to such a frightening new setting may cause a decline in age-appropriate behaviour and an increase in problem behaviour, making excellent medical care more difficult to deliver and the transition back home more challenging[2]. Common problems associated with physiotherapy in children admitted to the ICUs are child co-operation and adherence due to the distress[6].

Long-term hospitalisation, especially with low engagement, has been linked to delirium, prolonged hospital stay and an extended recovery period in previous research[3]. Children in PICUs are at risk for long-term psychological and psychiatric impairment[7]. The frequency of comorbidities rises in the PICUs, lowering child and family quality of life (QOL) and perhaps leading to impairment in cognition or psychology[3].

PICUs provide resources to help a child's emotional and developmental elements, such as child life specialists, in-house teachers, music, or pet therapy[4]. Child life specialists receive further training in child development, family dynamics and coping methods, and their unique mix of skills allow them to deliver treatment to critically sick children that other bedside caregivers are unable to provide[8]. Music therapy typically includes a music therapist who customizes the therapy session according to the child's music preferences and development[9]. The availability of these services is not even and is costly[4].

Virtual Reality (VR) has been utilized in medicine for more than two decades and has been linked to improvements in functions of motor, cognition and psychological systems[3]. VR has been used as an effective treatment as an analgesic for children with burns during physiotherapy[10], for procedural pain management[11], to reduce anxiety in cancer patients[12] and during dental procedures[13]. In a study by Ong TL, *et al* the VR intervention was shown to improve patients' ICU experience by decreasing the levels of anxiety and depression[14]. Despite the fact that research has demonstrated VR as an efficient, cost-friendly, safe and acceptable treatment for the management of acute procedure-related pain and emotional distress, its role in management of distress in children admitted to the PICUs has not been studied extensively.

Objectives

To study the effect of VR experience on distress in children admitted to the ICU.

Method

The current study is a randomised control trial (RCT) conducted on children in the age group 4-17 years, admitted to the PICU in a tertiary care hospital in Belagavi, India. The recruitment period was between 1st April 2021 and 31st March 2022.

Inclusion criteria: Children in the age group of 4-17 years, both male and female, admitted to the PICU, who were clinically stable, who were alert to interact with VR device and parent-child dyad willing to participate, were included in study.

Exclusion criteria: Children with a history of severe motion sickness or seizure disorder, children with an active infection, burn, or trauma that interferes with the headset placement and children with loss of vision were excluded from study.

Sample size: This was calculated by $N= 2*((Z_\alpha + Z_\beta)^2 * \sigma^2/d^2$ where, Z_α = 1.96 for 5% and significance level, Z_β was 1.28 (90% power), σ was 2.5 and 'd' was the effect size which is the difference in means/pooled standard deviation. Sample size was 32 children and each group (intervention and control) consisted of 16 children.

Children admitted to the PICU of a tertiary care hospital were approached for participation in the study. The children were then screened for eligibility in accordance with the criteria for inclusion and exclusion. After obtaining written informed consent from the parents and verbal/written informed assent from the child, they were recruited in the study. Baseline assessment was done using the Comfort Behaviour Scale and the State Anxiety Scale (STAI-CH). The participants were allocated to the intervention group or control group by random number table. Equipment used during intervention were sterilised before and after use. The assessment as well as the intervention was done by the primary investigator and took place in the PICU. Precautionary measures were taken to maintain good hygiene so as to reduce any chances of infection.

Intervention

Intervention Group: Immersive VR experiences were provided with a head mounted VR headset (Oculus Go standalone headset). The child and the parent were oriented to the VR headset and the experiences that will be shown. The videos were selected according to the child's preferences prior to the intervention. The therapist helped the child to wear the VR headset. The therapist operated the VR headset with the help of a smartphone app connected to the headset. The child viewed virtual simulation experience including serene nature landscapes such as safari, oceans[3] up to 15 minutes for 7 days 24 hours apart[14]. Appropriate instructions and feedback, if required, were given to the participant while performing the intervention. Vitals were monitored throughout the treatment duration and after every session; it was ensured that the child did not experience any adverse effect such as nausea or dizziness.

Control Group: The control group continued with the routine care given in the PICU.

The post intervention assessment was done 7 days after completion of the initial baseline assessments for both groups

Ethical issues: Approval to conduct the study was obtained from the Research and Ethics Committee of KLE Institute of Physiotherapy (Ref No. 578) on 16.07.2021. The purpose as well as the details of the study were explained to the parent and the child. Written informed consent was obtained from the parents and verbal/written informed assent from the child. The trial was registered in the Clinical Trials Registry-India (CTRI) under the registration number CTRI/2021/10/037497.

Statistical analysis: Data were analysed using SPSS Inc; Chicago, IL software version 26. Excel spreadsheet was used for calculation and tabulation of data. Testing of normality of the data was done with Kolmogorov Smirnov test. The dependent t-test was used for within-group analysis, and the independent t-test was used for between-group analysis. p-value <0.05 was considered significant.

Results

The difference in gender in both groups was compared using the Chi-square test (Table 1). The p-value obtained was 0.8370 which is not significant. Hence, the gender distribution is homogenous in both groups.

Table I: ***Gender differences in Intervention and Control groups***

Gender	Intervention group n (%)	Control group n (%)	Chi-square	p-value
Male	11 (73.3)	10 (66.7)	0.0420	0.8370
Female	04 (26.7)	05 (33.3)		
Total	15 (100.0)	15 (100.0)		

When mean ages were compared between both groups, p-value obtained was 0.0675 which is not significant (Table 2). Hence, both groups had similar age distribution as well.

Table 2: ***Mean ages of participants in Intervention and Control groups***

Group	Age (years) Mean ± SD	SE	t-value	p-value
Intervention group	8.67 ± 3.18	0.82	-1.9024	0.0675
Control group	11.27 ± 4.23	1.09		

Comfort Behaviour Scale: In the intervention group, distress scores decreased from 20.07±3.08 to 15.13±1.68 and the mean difference was 4.93±2.12 (Table 3). The p-value was 0.0001 which is significant which suggests that there is reduction in distress in the intervention group. In the control group, distress scores decreased from 18.60±3.33 to 15.40±2.90 and the mean difference was 3.20±2.21 (Table 3). The p-value obtained was 0.0001 which suggests that there is reduction in distress in both intervention and control group.

Table 3: ***Pre-intervention and post-intervention scores of Comfort B scale in Intervention and Control groups***

Group	Time-points of assessment	Mean ± SD	Mean difference ± SD	% of change	t-value	p-value
Intervention	Pre-intervention	20.07 ± 3.08	4.93±2.12	24.6	9.0118	0.0001*
	Post-intervention	15.13 ± 1.68				
Control	Pre-intervention	18.60 ± 3.33	3.20±2.21	17.2	2.2104	0.0001*
	Post-intervention	15.40 ± 2.90				

**Level of significance (p<0.05)*

The difference between pre- and post-intervention scores in intervention group was 4.93±2.12 and the control group was 3.20±2.21 (Table 4). The p-value was 0.0369 which is significant. This suggests a significant reduction in distress in the intervention group.

Table 4: ***Comparison of pre-intervention and post-intervention scores of Comfort B scale between groups***

Time-points of assessment	Intervention group Mean ± SD	Control group Mean ± SD	t-value	p-value
Pre-intervention	20.07 ± 3.08	18.60 ± 3.33	1.2512	0.2212
Post-intervention	15.13 ± 1.68	15.40 ± 2.90	-0.3081	0.7603
Difference	4.93 ± 2.12	3.20 ± 2.21	2.1918	0.0369*

**Level of significance (p<0.05)*

STAI-Ch scale: In the intervention group, anxiety scores decreased from 52.93±5.97 to 41.53±5.91 and the mean difference was 11.40±5.58. The p-value was 0.0001 which is significant which suggests that there is reduction in anxiety in the intervention group. The control group's distress scores decreased from 52.27±5.18 to 45.53±5.63 and the mean difference was 6.73±4.50. The p-value obtained was 0.0001 which suggests that anxiety was reduced in both groups.

Table 5: ***Pre-intervention and post-intervention scores of STAI-CH Scale in Intervention and Control groups***

Group	Time-points of assessment	Mean ± SD	Mean difference ± SD	% of change	t-value	p-value
Intervention	Pre-intervention	52.93 ± 5.97	11.40 ± 5.58	21.54	7.9154	0.0001*
	Post-intervention	41.53 ± 5.91				
Control	Pre-intervention	52.27 ± 5.18	6.73 ± 4.50	12.88	4.4955	0.0001*
	Post-intervention	45.53 ± 5.63				

**Level of significance (p<0.05)*

The difference between pre- and post-intervention scores in intervention group was 11.40±5.58 and the control group was 6.73±4.50 (Table 6). The p-value was 0.0176 which suggests that there was a significant decrease in anxiety within the intervention group.

Table 6: ***Comparison of pre-intervention and post-intervention scores of STAI-CH Scale between groups***

Time-points of assessment	Intervention group Mean ± SD	Control group Mean ± SD	t-value	p-value
Pre-intervention	52.93 ± 5.97	52.27 ± 5.18	0.3268	0.7462
Post-intervention	41.53 ± 5.91	45.53 ± 5.63	-1.8972	0.0682
Difference	11.40 ± 5.58	6.73 ± 4.50	2.5229	0.0176*

**Level of significance (p<0.05)*

Discussion

The current study assessed the effect of VR experience on distress in children admitted to the ICU. The results obtained suggest that there is decrease in distress in children between the age of 4-17 years after a 7-day intervention with VR experience.

The results obtained post-intervention demonstrated a significant reduction in distress and anxiety. To the best of our knowledge, the current study is the first RCT to explore the effect of a 7-day VR experience intervention on distress in children admitted to the ICU. Our results are in accordance with previous studies on the effect of VR interventions in reducing distress and anxiety[11,12,13,15,16]. However, these were either done for a single session[3] or for reducing anxiety during procedural anxiety, including dental procedures[13] or accessing Huber needle port[12] or cast removal[11]. Also, the present study differs from the previous studies in that the outcome measures used are standardized tools used for distress and anxiety whereas previous studies either used a self-developed questionnaire or a 4-point Likert scale[3,17].

VR group showed better results in reducing distress. Similar findings have been obtained in other studies which have evaluated acute anxiety during procedures. This could be due to VR's unique immersive ability to give a mentally and emotionally engaging environment by creating visual experiences from outside the ICU. It works in conjunction with traditional psychological and behavioural therapies which may include child life specialists but may be limited[3].

The results in our study suggest that there was a decrease in distress in the control group as well which may be attributed to adaptation of the child to the PICU environment over time. Another reason for reduction in distress could be due to improvement in the overall condition of the child which was co-related with the child's medical records. Although there is no literature available to support this, Rennick JE, *et al*[17] reported that children who are subjected to a greater number of intrusive procedures suffer from more severe psychological effects.

A study conducted on 32 children in the age group of 3-17 years was unable to link VR to reduced pain or anxiety, in contrast to the current study[3]. This could be because a single session of VR for five to twenty minutes may not have led to a significant impact on anxiety in the critical care setting[18]. Considering this, our study protocol included a 7-day protocol, 20 minutes per session to address the distress in children admitted to the ICU.

It was observed that the majority of the children enjoyed the VR sessions and would anticipate the upcoming VR session. Similar findings were reported by Badke CM, *et al*[3] where one hundred percent (n=31) said they enjoyed the VR session, and eighty-four percent said they wished to use it for longer. One hundred percent of parents strongly agreed or agreed that their child enjoyed VR session, and one hundred percent of parents agreed or strongly agreed that they were happy to watch their child use the VR device[3].

It was noted that younger children had some problem with getting used to the VR device and its controls as compared to the older children and there were some difficulties in using VR which included VR device controller battery draining out during the session and restriction in neck movement required for VR in particular positions like lying supine.

Studies in the past have reported that there is a lack of seeking treatment for the psychological outcomes after PICU admission and suggest that a way to

tackle this problem would be to begin the intervention while the patient is still in the hospital instead of waiting for a follow-up appointment[10]. Hence, the present study addresses this need for intervention to reduce distress during the PICU stay in children.

VR has proved to be a feasible option to traditional psychological therapy in the treatment of psychological stress. VR has been shown to be superior to traditional hospital distraction techniques such as toys, television, literature, and parental consoling in several trials. Studies suggest that among children with chronic diseases, the subjective sensation of 'presence' in virtual worlds can be employed as a therapeutic replacement for natural play and exploration, decreasing the negative psychological effects associated with hospitalization[13].

Conclusions

The present study concludes that a 7-day VR experience intervention is effective in decreasing distress in children admitted to the ICU.

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