

The Impact of Virtual Reality on Children's Fear, Pain, and Physiological Parameters during Cannula Insertion for Receiving Chemotherapy in Pediatric Patients

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Abstract

Background: Chemotherapy frequently causes pain, fear, and anxiety. Children typically practice this sense during invasive chemotherapy-related procedures, of which cannulation is one. The most frequent medical operations for children are cannulation insertions, which are frequently distressing and uncomfortable for both children and their parents. **Objective:** This study aimed to evaluate the impact of virtual reality on children's fear, pain, and physiological parameters during cannula insertion for receiving chemotherapy in pediatric patients. **Methods:** A randomized controlled trial of a two-group design, with a convenient sample of 60 children admitted to the oncology department at the Cancer Institute in Assiut governorate. Eligible children were randomly divided into an experimental and a control group. Children in the experimental group were shown a VR (eyeglasses specialized for that goal) video during cannulation. While subjects in the control group received cannulation without any distraction method. The outcome variables were assessed by the investigator before, during, and after cannulation. Three tools were used to collect data for this study: Personal and clinical data sheet, Children's Fear Scale, and The Objective Pain Scale. Statistical analysis of the data was carried out. **Results:** The children's ages ranged from 5 – 20 years. Respiration and pulse rates were significantly less in children who used VR especially during and after cannulation time points. Significantly less pain was felt by children using the VR eyewear. Also, fear and pain significantly decreased in the study group during and after cannulation. **Conclusion:** VR can be successfully used to distract children decrease the amount of fear, and pain, and enhance physiological stability among chemotherapy. **Implications for Practice:** VR can be a great way to distract children from their fear and pain, which can be a nightmare for kids and their parents during any invasive procedure.

Keywords: Chemotherapy, Cannulation, Distraction, Pain, Fear, Virtual reality.

Introduction:

Many methods and complementary therapies have been attempted recently to address the side effects of chemotherapy (Özdelikara & Tan, 2017). Reflexology, relaxation, music, and creativity are among the techniques that help patients and have been shown to mitigate the negative effects of chemotherapy (Dikmen & Terzioglu, 2019).

Pain is the most prominent associated complication of chemotherapy (Farquhar-Smith, 2011). Distraction has been used as a non-pharmacological method for managing pain perception during painful procedures such as punctures. Distraction tools can be distraction cards, buzzers, listening to music, and video games (Özkan & Polat, 2020).

The American Academy of Pediatric Dentistry (AAPD) defines distraction as “the

technique of diverting the patient's attention from what may be perceived as an unpleasant procedure" when used as a behavior-guiding tool. Dental clinics employ audiovisual distraction techniques, which have proven to be highly effective in reducing anxiety in young patients (Felemban, et al., 2021). A novel approach in the medical industry to help with patient behavior management is virtual reality (VR) distraction, which is defined as "a human-computer interface that enables the user to interact dynamically with the computer-generated environment." It has the benefit of providing an immersive virtual experience that blocks out outside stimuli that may make a patient feel bad, especially if they are young. VR-enabled distraction has proven to be beneficial for both adult and pediatric patients during a variety of dental treatments, from basic anesthesia to pulpal, periodontal, and restorative therapy (Felemban, et al., 2021).

Children's painful experiences can be managed by virtual reality (VR), including dressing changes, cleaning and bandaging burns, punctures, and managing both acute and chronic pain (Joo, 2021 and Chen, et al., 2020). By actively engaging patients in an activity that demands cognitive or behavioral functioning, virtual reality (VR) helps patients' brains get distracted from their discomfort. As a matter of fact, a well-designed distraction device offers multimodal stimulation through the provision or stimulation of various sensory signals, adaptation to the developmental stage, and high levels of interaction to hold the user's attention (Cooper, et al., 2018). Because virtual reality (VR) simultaneously stimulates the visual, aural, and cognitive senses, it is a new distraction strategy that should prove to be more successful than older approaches (Wang, et al., 2022). Since virtual reality (VR) is a relatively new technology, its widespread application in scientific and medical research has been hindered by its high cost, accessibility issues, and software development limitations (Gates, et al., 2020).

Significance of the Study:

Children's procedural discomfort may be successfully reduced by using virtual reality (VR) as a diversion (Chen, et al., 2020 and Shetty, et al., 2019). Although many medical procedures include the use of needles, many people—especially young ones—are afraid or anxious about them. Healthcare providers face an important challenge. They want to balance between giving treatment for various conditions and fear and anxiety imposed by treatment itself. Many children avoid treatment and have poor adherence to medication as related to needle phobia. Anxiety is well known to intensify pain perception (Orenius, et al., 2018). Distraction is a useful method for managing pain perception and reducing fear during puncture. It includes listening to music, video games, and buzzers. Virtual reality has recently been proposed as a pain-reduction strategy for kids. It may be used to treat burns and clean burn wounds, as well as control both acute and chronic pain in children. It can also be used to change bandages and punctures (Panda, 2017). Virtual reality is considered a useful method of distraction among children because it involves sounds, moving images, and interaction with the situation which requires thinking and cognitive power (Özalp Gerçekler, et al., 2020). Therefore, the purpose of our study is to assess how virtual reality distraction affects physiological parameters, fear, anxiety, and discomfort during the insertion of a cannula for chemotherapy in pediatric patients.

Aim of this study:

This study aimed to evaluate the impact of virtual reality on children's fear, anxiety, pain, and physiological parameters during cannula insertion for receiving chemotherapy in pediatric patients at the Upper Egypt Cancer Institute in the Assiut governorate.

Research Hypothesis:

We hypothesized that virtual reality distraction will decrease fear, anxiety, and pain and enhance physiological stability during cannula insertion for receiving chemotherapy in pediatric patients.

Operational definitions

1- Virtual reality: is the technology that provides almost real and/or believable experiences effectively. To achieve this digital glass was used.

2- Physiological parameters: include respiratory and heart rates, temperature, oxygen saturation, and sweating. We assess in the study pulse and respiratory rates, and temperature.

Subjects and Methods:

Research Design: A randomized controlled trial of a two-group design was used in this research.

Setting: The study was conducted in pediatric oncology outpatient clinics at Upper Egypt Cancer Institute in Assiut governorate.

Subjects: A convenient sample of 60 admitted children were recruited in this study. Children were eligible if they were; 1) 6-17 years old, 2) undergoing\receive chemotherapy, 3) free from epilepsy or psychological disorders. The recruited children were randomly assigned to study and control groups. A random allocation list was prepared by using randomization software (Excel) to allocate subjects to any of the groups, one by one according to their order of admission.

Cohen's definition was used to determine power analysis and effect estimates for each outcome variable. 0.2, 0.5, and 0.8 effect sizes were deemed minor, moderate, and substantial, correspondingly (Semerci, et al., 2021). We needed a sample size of 12 for each group, but we maximized the sample size to be 30 children in each group. The data were analyzed using SPSS version 24 utilizing mean and standard deviation values from previous research by (Felemban, et al., 2021 and Panda, 2017 and Cohen, 1992), with a power of 80%, and a confidence level of 95%.

Tools of data collection: Three tools were used to collect data for this study:

1- Personal and clinical data sheet: It included two parts:

- Part one; includes sociodemographic data of the child e.g. Child code, Initial name, age, and sex).

- Part two; includes data about child disease and physiological parameters such as respiratory and heart rates, temperature, and sweating.

2- Children's Fear Scale (CFS): It was developed by **McMurtry, C.M., et al., 2011** and used to measure fear and anxiety. This scale is made up of five sex-neutral faces arranged in a row, with the far-left face representing no fear at all and the far right face representing great terror. In response, the rater selects the face from the five that best represents their level of worry and terror. Cronbach's alpha coefficient of the draft Children's Fear Scale was found to be 0.86 for the overall scale (**Aminabadi, 2012**).

3- The Objective Pain Scale: It was developed by **Wilson & Doyle, 1996** and used to measure pain. It contains four items (crying, movement, agitation, and posture) each item rates from 0 to 2 This yields a final score ranging from 0 to 10. Evaluation of the overall pain score: 0 = At ease and content, 1-3 = Moderate unease, 4-6 = Moderate discomfort; 7-10 = Severe pain. Cronbach's alpha coefficient of the draft of the Objective Pain Scale was found to be 0.70 for the overall scale (**McMurtry, et al., 2011**).

Tools validity:

Five professionals with advanced degrees in psychiatric and mental health nursing, and pediatric Nursing evaluated the research tools for validity. As required, the adjustments were completed.

Tools reliability:

Cronbach's Alpha was utilized to assess the reliability of the tools; it was 0.86 for the Children's Fear Scale (CFS) & 0.70 for the Objective Pain Scale.

Ethical and legal considerations:

The Assiut University faculty of nursing's scientific research ethics committee provided ethical approval before the study's commencement on 27/8/2023. The manager of the pediatric department at Upper Egypt Cancer Institute in Assiut governorate granted formal approval. Before data collection, pediatric patients and parents were told of the study's purpose and nature, which didn't include any injury or pain, and oral consent was obtained before any data were collected. Additionally, they received assurances that the data was private and would only be used for research. The study's participants were made aware that participation was optional and that they had the choice to discontinue at any time. They were also advised that the data collected would be kept anonymous and confidential.

Pilot study:

To evaluate the tools' clarity and applicability, a pilot study including six pediatric patients, or 10% of the entire sample, was carried out. The instruments were left unchanged. They were so included in the sample as a whole.

Procedure:

Two phases of the actual fieldwork, which lasted three months from the beginning of September 2023 to November 2023, were involved:

The initial stage of preparation

Involved the researchers reviewing previously published and currently accessible literature that was pertinent to the study topic to gain a thorough theoretical understanding of the many facets of the issue. They also set up the study's instruments.

The implementation phase:

□ Following the evaluation of the study's proposal by the nursing faculty's ethical and scientific committee, to obtain formal approval to conduct the study, the Dean of the Nursing Faculty at Assiut University wrote a letter to the

manager of the pediatric department at Upper Egypt Cancer Institute in Assiut governorate.

□ After receiving formal approval to carry out the study. Each pediatric patient and parent were questioned individually by the researchers, who also gave a brief explanation of the study's goals and obtained her oral agreement to participate.

□ According to the control group, the researchers visited pediatric patients and parents in the pediatric oncology outpatient clinics for two days a week. Each day, about three to four sheets were completed. Each interview lasted between 7 and 12 minutes, depending on the patient's schedule. Fear, pain, and Physiological parameters will be assessed using the Fear Scale, WBS, and FLACC before, during, and after cannula insertion for receiving chemotherapy for control groups.

□ While subjects in the control group received cannulation without any distraction method. Nurses follow routine care to insert the cannula for them such as keeping parents/mother with the child during cannulation, wearing gloves, and cleaning the insertion site, sometimes nurses talk to the child saying "It is a brief procedure" and "It is a simple tingling". After the control group finished, the researchers began visiting pediatric patients and parents in the pediatric oncology outpatient clinics to take a study group two days a week. Every day, about two to three papers have been completed. Each interview lasted between 15 and 20 minutes, depending on the patient's schedule. Fear, anxiety, pain, and physiological parameters were assessed using the fear scale, WBS, and FLACC before, during, and after cannula insertion for receiving chemotherapy for the study groups. Additionally, researchers helped the study groups wear VR glasses and watch Cartoon Characters and Cartoon videos for 8-12 minutes or more such as Superman, Mackie, or Amusement Park. As the children preferred these videos, thus done before, during, and after cannula insertion for receiving chemotherapy.

Statistical Analysis:

SPSS version 22 was used for data entry and analysis (Statistical Package for Social Science). Numbers, percentages, means and standard deviations were used to show the data. Kolmogorov-Smirnov and Shapiro-Wilk tests were used to verify that the data distribution was normalized. Since the data were not regularly distributed, non-parametric tests were employed for data analysis. The groups' differences in the outcome variables—physiological parameters, fear, and pain—were compared using the Mann-Whitney t-test. When $P < 0.05$, the P-value is regarded as statistically significant.

Results:

Figures 1 and 2 represent gender and age distribution among the sample. Males represent 58% of the sample, while participants' age ranged from 5 to 10 years equal to 60% of the sample size.

In Table 1 physiological parameters are compared between the groups before-during-after cannulation. Temperature means did not differ among groups even before, during, and after cannulation. Also, means of pulse and respiration before cannulation did not significantly differ among the study and control groups. While, during and after means were higher in the control group (pulse: during= 120.30, after= 117.03; respiration: during=23.10, after= 22.10) than study group (pulse: during= 111.83, after= 102.77; respiration: during= 21.53, after= 20.07) with statistical significance differences between them.

Table 2 shows the comparison of fear and pain means before, during, and after cannulation for the study group. Fear and pain mean before cannulation in the study and control groups did not statistically differ ($P = .598$, $P = .865$ respectively), while during and after means differed with statistical differences between them

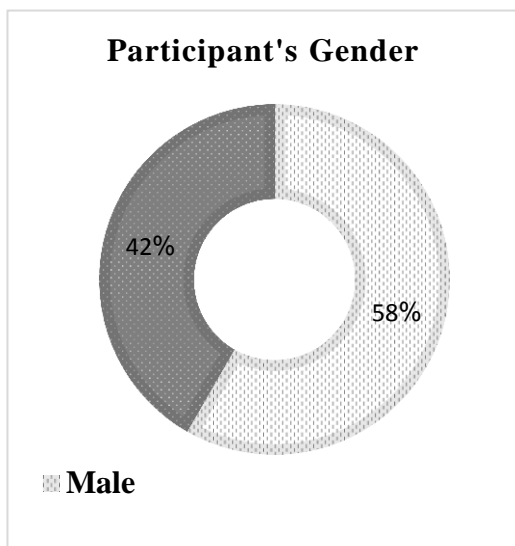


Figure 1: Sample's Gender Distribution

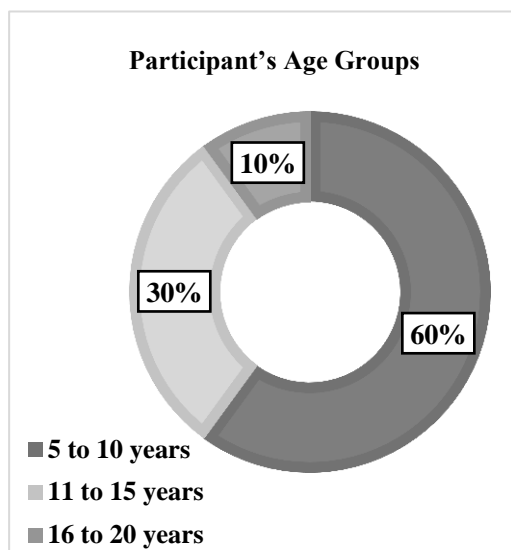


Figure 2: Sample's Age Group

Table 1: Physiological Parameters Before, During, and After Cannulation among the Group

Physiological Parameters		Control Group Mean(SD)	Study Group Mean(SD)	P- value ^a
Heart rate	Before	123.30(13.12)	123.63(12.33)	.946
	During	120.30(13.20)	111.83(12.28)	.026
	After	117.03(13.36)	102.77(12.45)	.000
Respiration	Before	23.90(1.76)	24.13(1.52)	.624
	During	23.10(1.78)	21.53(1.50)	.001
	After	22.10(1.78)	20.07(1.43)	.000
Temperature	Before	37.41(0.22)	37.41(0.23)	.928
	During	37.36(0.22)	37.26(0.24)	.099
	After	37.28(0.22)	37.24(0.38)	.166

^a Mann-Whitney test used to define the variation between the study groups; two-tailed test results with significance set at $P \leq .05$. Abbreviations: SD, standard deviation; P, probability.

Table 2: Pain and Fear Before, During, and After Cannulation Among the Study Group

Outcomes		Control Group Mean(SD)	Study Group Mean(SD)	P- value ^a
Fear	Before	4.16(0.91)	4.30(0.83)	.598
	During	3.06(0.94)	1.56(0.72)	.000
	After	1.96(0.88)	1.13(0.34)	.000
Pain	Before	2.49(0.56)	2.50(0.54)	.865
	During	1.99(0.31)	1.35(0.44)	.000
	After	1.38(0.42)	1.07(0.23)	.000

^a Mann-Whitney test used to define the variation between the study groups; two-tailed test results with significance set at $P \leq .05$; Abbreviations: SD, standard deviation; P, probability. (P = .000)

Discussion:

Virtual reality is a cutting-edge method of diversion that helps all children receiving IV

chemotherapy feel less discomfort. It is a potentially helpful and entertaining solution for kids enduring traumatic surgeries and experiencing excruciating pain (Wilson & Doyle, 1996). The main idea behind VR's

involvement is relieving pain and limited attentional capacity to it. When patients are in pain, they need to pay attention to it. If they can

The present study revealed that, virtual reality (VR) dramatically decreased pain and terror levels as well as heart and respiration rates both during and after cannula insertion among children receiving chemotherapy. On the same line, (Won, 2017) stated that VR dramatically lowered heart rates and considerably decreased feelings of pain, fear, and dread among burn-injured youngsters.

According to this study, the VR short movies were using to distract patients' attention and relieve pain of canula insertion. On the same line another study revealed that, distraction strategies are frequently employed during short-term, unpleasant, or scary operations. They entail using stimuli like music, films, and dialogue to draw the mind's focus away from unpleasant stimuli. Distraction could have naturally beneficial impacts on anxiety, mood, and fears—all of which can change how painful something feels. (Arane, et al., 2017).

Mantegazza et al., 2021 noted that most of the studies showed that using VR to distract during scheduled and unscheduled needle-related procedures, such as IV cannulation, worked better than having no distraction at all. Conversely, no study found that VR distraction performed worse than other forms of entertainment, which is in line with the findings of the current research.

The current study showed that heart rate and respiration decreased after using VR movies among pediatric patients who Receiving Chemotherapy and during Cannula Insertion. In contrast with this study, (Wong et al., 2023) stated that there is no statistically significant difference was seen between control and study groups regarding physiological parameters.

Conclusion:

The results of the present review indicate that VR has beneficial effects on procedural pain in children, compared to no intervention. This result of using VR intervention for

deflect part of that focus by using virtual reality, for example, they will react to pain signals more slowly. (Kaya, & Özlü, 2023).

pediatric patients undergoing cannula insertion during receiving chemotherapy to reduce pain, and fears also to decrease heart rate and respiratory rate during and after the vain puncture. The findings also indicated that children might be provided with procedural information as well as diversion during an IVR intervention. IVR has the potential to enhance children's experiences with needle-related or painful and anxious intrusive treatments since it is becoming more accessible and cheaper.

A promising new technology that has special chances to modify the perception of pain is virtual reality. To maximize pain relief, VR research should also concentrate on figuring out how to link VR software and films with comparable age groups.

Study limitation: -

The process of acceptance to apply procedure in pediatric oncology outpatient clinics is very long and there are many restrictions in this place.

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