ORIGINAL RESEARCH

International Journal of Nursing Education
Volume 14 No. 4, October-December 2022

Development of a Virtual Reality Nursing Assistance System to Positively Enhance Rectal Medication Adherence in Children

Wei Kai Liou[1] , Pao Ju Chen[2]*

[1]Assistant Professor, College of Management and Design, Ming-Chi University of Technology, 84 Gungjuan Rd., Taishan Dist., New Taipei City 243303, Taiwan (R.O.C), [2]Assistant Professor, Department of Nursing, Asia Eastern University of Science and Technology, 58, Sec.2, Sihchuan Rd., Banciao Dist., New Taipei City 220303, Taiwan (R.O.C)

How to cite this article: Liou WK, Chen PJ. Development of a Virtual Reality Nursing Assistance System to Positively Enhance Rectal Medication Adherence in Children. 2022;14(4):109-116

ABSTRACT

Children may feel uneasy, anxious and fearful when faced with an invasive procedure because they cannot understand the reason for their illness and they fear the destruction of the integrity of their bodies. In rectal drug delivery (the use of anal suppositories), children often move their hips and cry during the procedure, which may cause the suppository to inadvertently break, slip out, or be misplaced in the vagina. In order to find to a solution to the clinical issue, this study focuses on the application of virtual reality in developing a VR nursing assistance system that can be used in clinical practice with only ordinary cell phones and simple VR headsets, called "Little Hero Saves the Earth". This system allows children to immerse themselves in the plot of a story through a first-person perspective (as the "little hero"). When the little hero needs to have the superpower rocket fitted (what the child perceives in the first-person perspective), the nurse places the child in a side-lying position before inserting the suppository (superpower rocket) in sync with the plot. This serves to reduce the child's fear of invasive procedures, encourage the child to think of anal suppositories in a positive way, and lead to a sense of autonomy and accomplishment in the child, thus creating a positive, successful experience.

Keywords: virtual reality, nursing assistance system, rectal drug delivery, anal suppository, anxiety, fear.

INTRODUCTION

Being treated for an illness can be a deeply traumatic and stressful event for children of all ages, and it can easily result in negative reactions and may even affect children's personality development[1]. When a child is stressed, it can make procedures extremely difficult for the health care provider and also affect the child's physical and mental development; for example, the child may cry, refuse treatment, hit, push, or engage in other aggressive behaviors when the child sees the health care provider again[2]. Children are resistant to and fearful of invasive procedures, and rectal drug delivery (anal suppositories) is an invasive procedure that often causes great physical and psychological stress and trauma due to their limited cognitive development and stress management skills[3]. Minimizing stress and fear is a key consideration for health care providers. However, sick children often require rectal medication to relieve symptoms such as fever, vomiting, and

Corresponding Author: Pao Ju Chen, PhD, Department of Nursing, Asia Eastern University of Science and Technology, 58, Sec.2, Sihchuan Rd., Banciao Dist., New Taipei City 220303, Taiwan (R.O.C)

E-mail id: Email: fk036@mail.aeust.edu.tw, Tel: 886-2-7738-8000 ext. 6123,

coughing, yet they cry, become restless, and are extremely reluctant to cooperate every time health care providers administer anal suppositories, resulting in poor quality of care and treatment. Children under the age of 12 mostly communicate in nonverbal forms[4], thus various skills in games are needed to guide children in expressing their fears, anxieties, and conflicts naturally and spontaneously in a non-stressful situation and to help them relieve the stress they are under during the treatment process[5, 6], so as to increase their sense of self-control, improve their understanding of treatment and reality, reduce their fears and stresses toward treatment, and even enhance their adherence to treatment[6].

Virtual reality (VR) is a way of using computer graphics to simulate the real world. The human-computer interaction is achieved through the use of multiple senses, allowing children to explore a virtual environment through seeing, hearing, touching, and even smelling; VR is immersive, which allows users to be completely absorbed or enveloped in the virtual environment by using cognitive strategies to shift their attention[7]. The literature suggests that when children with burns continue to cry during and after dressing changes, interventions with VR can reduce pain and anxiety by diverting the child's attention and lowering the incoming signals of pain[8]. Immersing in-hospital patients aged 6 to 12 years in intravenous injection scenarios in VR while they are receiving the injections and VR games after the injections were effective in reducing the sensation of pain, fear, and the time required for the injections[9]. VR has also been used to reduce anxiety and distract patients from pain in pediatric dental treatments[10], as well as to distract adolescent cancer patients from their pain while they are undergoing lumbar puncture[11]. All of the aforementioned studies have shown that VR is indeed effective in the physical and psychological treatment of children and adolescents. Therefore, this study focuses on the application of VR technology and the development of a VR nursing assistance system called "Little Hero Saves the Earth", which takes children into a scenario with a story and allows them to forget their fear of reality by distracting them from the invasive procedure. The children are immersed in the plot in the first-person perspective (the main character of the story is named Little Hero), and the plot of the story is that the superhero Rocketman and Little Hero need to be fitted with superpower rockets (anal suppositories) in turns; this is so that children can understand the process of being treated with an anal suppository and be relieved of their restlessness, anxiety and fear, which not only enhances the effect of the treatment but also the connection that children make between anal suppositories and positivity.

SYSTEM DEVELOPMENT AND APPLICATION

1. Production team

The VR system utilized in this study was jointly developed by the AR & VR Lab of the Department of Nursing at the Asia Eastern University of Science and Technology and the Virtual Space Lab of the College of Management and Design at Ming-Chi University of Science and Technology.

2. Production background

In clinical settings, children may cry or feel anxious and fearful when faced with invasive procedures, such as rectal drug delivery (anal suppositories), and often move their hips and cry during the procedure, which may cause the suppository to inadvertently break, slip out, or be misplaced in the vagina. In order to come up with a solution to this clinical problem, this study brought together licensed and clinically-experienced nurses, 3D animation designers and VR system engineers to jointly develop a VR nursing assistance system called "Little Hero Saves the Earth", which can be used in clinical practice. By immersing children in VR scenarios and storylines, the VR system will help to reduce children's fear of invasive procedures, enhance the positive impression they have of such procedures, attain treatment results, and improve the nurse-patient relationship.

3. Story and character design

(1) **Plot**

The Doctor explains to the child that Earth is currently under attack by the Germ Man, and that Earth needs the help of the Little Hero (the child). Next, the two enter the Superpower Laboratory, where the doctor explains that Little Hero (the child) must be fitted with a superpower rocket in order to travel to Earth with Rocketman and defeat Germ Man. Then Rocketman demonstrates the installation procedure for the superpower rocket, allowing the child to think of the anal suppository in a positive way first, and guides the child in making movements and using postures that are needed during treatment. The child then begins to install the superpower rocket, and that is when the nurse simultaneously inserts the anal suppository to complete the treatment. Because of the plot, the child thinks of anal suppositories in a positive way, continues to be immersed in the role of Little Hero, who helps Rocketman defeat Germ Man and restore peace to Earth, and ultimately gains a sense of accomplishment and satisfaction.

(2) Character and medical purpose

(a) Main purpose: Having children receive treatment through rectal drug delivery (anal suppositories)

(b) Characters: Little Hero, Rocketman, Dr. Teddy, Germ Man, Germ Army

(c) Target: Children aged 4-12 years

(d) Medical purpose and method: When Little Hero (the child) is having the superpower rocket fitted, the nurse places the child in a side-lying position before inserting the suppository (superpower rocket) into the body in sync with the plot; once the rocket fills with energy, Little Hero will fly to Earth at a speed that is faster than light, save the planet, and restore peace. In this manner, children will learn to think of the invasive anal suppository in a positive way, which will enhance their autonomy and sense of accomplishment.

4. VR 3D animation production

The VR 3D animation of "Little Hero Saves the Earth" was designed for the invasive procedure of placing anal suppositories, and includes character selection, plot arrangement, voiceover, music, background image illustration and modification. The VR 3D animation of the system is based on the needs and story ideas of nurses with actual clinical experience; therefore, this study used iClone, a 3D animation software with better visualization and a lower production threshold, to construct and produce a 3D virtual environment and animation for the virtual characters. The program was chosen to reduce communication barriers between animation producers and nurses, and to enable nurses who do not have basic 3D animation skills to quickly and effectively construct the characters and scenarios needed for the plot from the software's database of 3D materials after receiving a few weeks of basic animation training, and then export the finished 3D animation in a format that can uploaded into VR programs and the system. This study's success in producing VR 3D animation means that the ability to produce VR 3D animation is no longer limited to professional animators. In the future, nurses will be able to produce VR 3D animation for various nursing assistance systems in accordance with clinical needs, and also create VR nursing assistance systems that meet clinical needs more efficiently based on their own nursing expertise, such as nursing assistance systems for having children ingest medication, intravenous injections, dressing changes, and more.

5. VR system development

After considering various factors such as the convenience in clinical use, the cost and time of producing VR digital content, the cost of equipment and the ease with which equipment

could be set up, this study developed a model that used a VR program for cell phones and a low-cost and simple VR headset. The overall development cost was low, and the result was an innovative and interactive nursing assistance VR system. After integrating the aforementioned VR 3D animation with Unity through a VR SDK, the functions of the VR system were programmed, the coding was done for interactive portion of the program, the app was packaged and tested, and, finally, the integrated system was exported to a VR app that can be run on a generic cell phone. This VR system platform is low-cost, effective, easy-to-operate, and highly reliable, which makes it suitable for use by clinical nursing staff when nursing assistance is required.

6. The operation of the system and nursing assistance procedures

- **Step 1:** Enter the "Little Hero Saves the Earth" app; nurses can switch to the VR animation scenario on their phone at any moment, and they can monitor the child's VR screen at any time through the big screen's synchronization function (Figure 1).
- **Step 2:** Under the guidance of the nurses, the child puts on the VR headset and becomes immersed in the plot as a character (Little Hero) in the first-person perspective.
- **Step 3:** In the VR scenario, Dr. Teddy explains to the child that Earth is currently under attack by Germ Man, and that Earth needs the help of Little Hero (the child) (Figure 2).
- **Step 4:** Dr. Teddy explains to the child that a superpower rocket must be fitted in the child's body first for the child to go and save Earth.
- **Step 5:** The child watches Rocketman being fitted with a superpower rocket (an anal suppository in reality) to understand the procedure and to relieve their restlessness, anxiety and fear.
- **Step 6:** Next, it is Little Hero's turn to be fitted with a superpower rocket. During this step, the nurse places the child in a side-lying position and inserts the anal suppository into the body in sync with the VR scenario on the screen, thus increasing the child's positive impression of the anal suppository (Figure 3).
- **Step 7:** Allow the child to continue to play the role of Little Hero, work with Rocketman to defeat Germ Man, and help restore peace to the Earth, thus enhancing the child's autonomy and sense of accomplishment as well as giving them a positive, successful experience (Figure 4).

Fig. 1: Nurses can monitor the child's VR screen at any time through the big screen's synchronization function.

Fig. 2: The VR scenario shows that Earth is currently under attack by Germ Man and that Earth needs the help of Little Hero (the child).

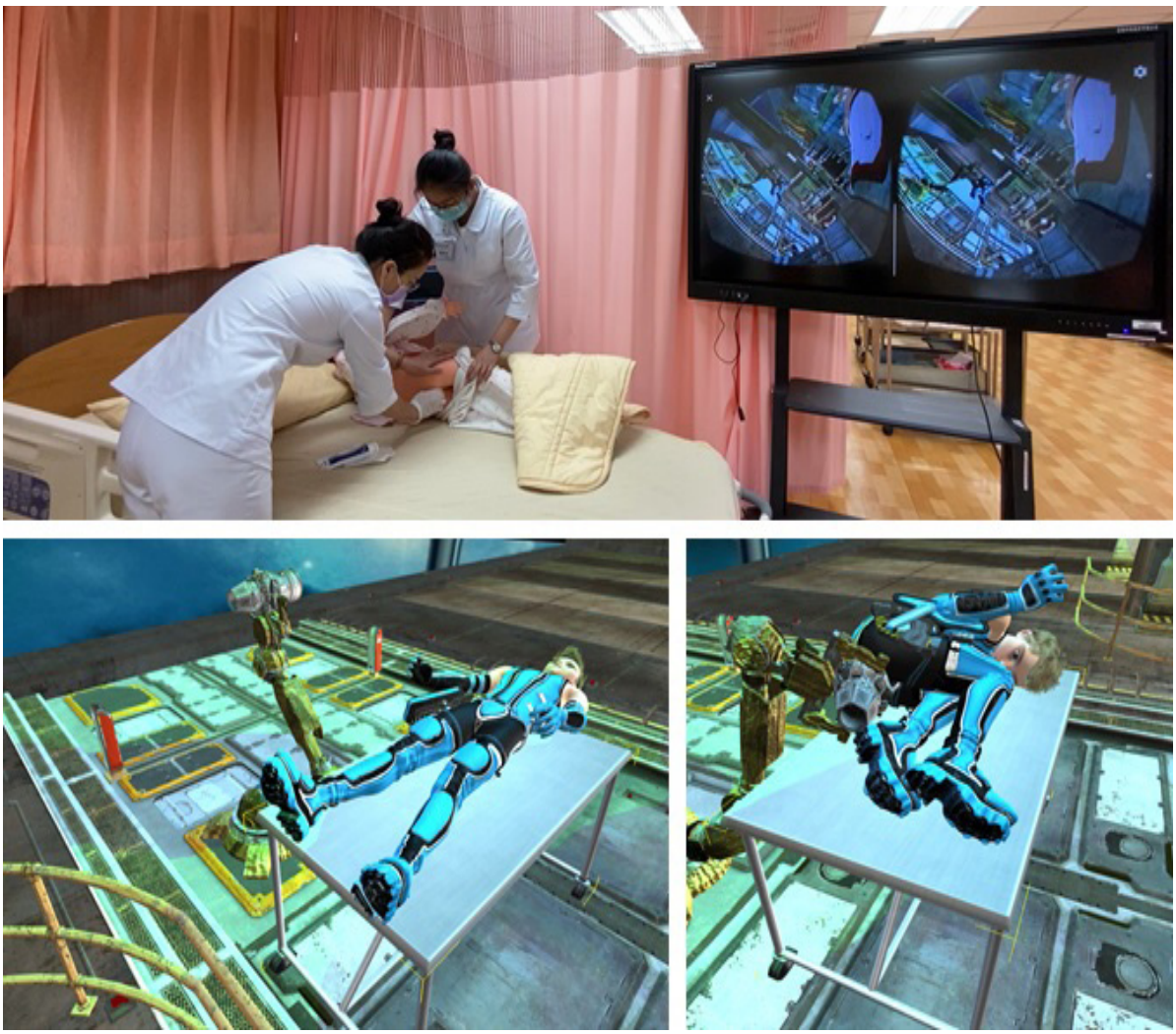

Fig. 3: The nurse places the child in a side-lying position and inserts the anal suppository into the body in sync with the VR scenario on the screen.

Fig. 4: The child continues to play the role of Little Hero, and defeats Germ Man together with Rocketman to help restore peace to Earth

RESULTS AND DISCUSSION

he main purpose of the VR animation game developed in this study is to provide children with positive enhancement in their adherence to rectal drug delivery. Previous studies have shown that the use of VR sensory stimulation distracts children from invasive procedures and reduces pain, anxiety, and fear during medical procedures[9, 12, 13]. However, after passively receiving treatment, children still did not understand the reason behind the procedure and continued to feel anxious and fearful the next time they faced an invasive procedure. Therefore, our VR system integrates virtual and real environments to immerse children in a story and a role, and have them participate through the first-person perspective for three important purposes: first, to allow the child to understand the process of using an anal suppository, which in turn alleviates anxiety and fear; second, having the nurse place the child in a side-lying position before inserting the suppository (superpower rocket) in sync with the plot enhances the child's positive impression of rectal drug delivery; third, the story of saving Earth and resolving a crisis is used to ease the children into the process, and leads to a positive experience of success. In this way, not only will the child's physical and mental development be enhanced, but the parents' stress will be reduced because the child will no longer be afraid of invasive procedures. Virtual reality is a non-pharmacological intervention that is an empirically supported, feasible, and cost-effective solution for managing pain and anxiety during routine

invasive procedures in a pediatric setting; it reduces adverse and traumatic reactions to medical procedures, and improves patient and patient family satisfaction with the care that was provided. This study is currently at the stage in which the development of VR tools is complete. VR is very easy to use, and its future use is recommended for pediatric wards and outpatient clinics, which can benefit more families with children as well as lessen the burden of health care providers.

CONCLUSION

Adults often think that just holding down a child would make the process of inserting an anal suppository quicker, but children will cry and become more fearful the next time once they have had an unpleasant experience. Invasive procedures that cause pain and anxiety can be psychologically traumatic for children, making the treatment process more difficult and the relationship between the children's family and the health care provider worse. In addition, the stress brought on by various invasive procedures can cause children to lose their sense of autonomy and control. According to Erikson's theory of psychosocial development, feelings of guilt, low self-esteem and helplessness can occur when children are often frustrated. The fun, flexibility and controllability of virtual reality games help children forget the pain and fear of reality. The study's immersive virtual reality system is a contextualized projection that allows children to not only divert their attention from unpleasant feelings brought about by the invasive procedure, but also enhance positive connections with rectal drug delivery, demonstrate self-confidence, build positive experiences of success, and avoid feeling a loss of autonomy and control. Further developments in VR equipment and study processes are also needed.

Conflict of Interest Statement: The authors declare that they have no conflicts of interest.

Source of Funding: None.

Statement of Human Rights: We did not submit a human trial review to the Research Ethics Review Committee. As it is a regular teaching activity, we have only used the developed teaching aids as a precursor test.

Acknowledgment: The authors would like to thank the nursing student participants in this study for their time and patience.

REFERENCES

1. Salmela M, Salanterä S, Aronen ET. Coping with hospital-related fears: Experiences of pre-school-aged children. Journal of Advanced Nursing. 2010;66(6):1222-1231.
2. Hockenberry MJ, Wilson D, Rentfro AR, McCampbell L. Study Guide for Wong's Nursing Care of Infants and Children – E-Book. Elsevier Health Sciences. 2019.
3. Crowley MA, Storer A, Heaton K, Naccarato MK, Proehl JA, Moretz JD, Li S. Emergency nursing resource: needle-related procedural pain in pediatric patients in the emergency department. Journal of Emergency Nursing. 2011;37(3):246-251.
4. Piaget J. Play, dreams, and imitation in childhood. New York: Norton. 1962.
5. Koukourikos K, Tzeha L, Pantelidou P, Tsaloglidou A. The importance of play during hospitalization of children. Materia Socio-Medica. 2015;27(6): 438-441.
6. Pontes JED, Tabet E, Folkmann MÁDS, Cunha MLDR, Almeida FDA. Therapeutic play: Preparing the child for the vaccine. Einstein. 2015;13(2):238.
7. Isdale J. 1993, October 8. In what is virtual reality? A homebrew introduction and information resource list. Retrieved June 22, 2022 from http://www.isx.com.
8. Lien SY, Chuang WY, Yang JY, Chan A, Chung WY, Wong KS. An exploration of virtual reality for the relief of pediatric burn pain. Chang Gung Nursing. 2007;18(2):294-306.
9. Hsu MF, Whu YW, Lin IC, Liu CY, Lai FC, Liu PC, Chen CW. Effectiveness of virtual reality interactive play for children during intravenous placement: A randomized controlled trial. Asian Nursing Research. 2022;16(2):87-93.
10. Sullivan C, Schneider PE, Musselman RJ, Dummett Jr CO, Gardiner D. Behavior: The effect of virtual reality during dental treatment on child anxiety and behavior. Journal of Dentistry for Children. 2000;67(3):193- 196.
11. Wint SS, Eshelman D, Steele J, Guzzetta, LE. Effects of distraction using virtual reality glasses during lumbar punctures in adolescents with cancer. Oncology Nursing Form. 2002; 29(1):33-36.

12. Ali S, Rajagopal M, Stinson J, Ma K, Vandermeer B, Felkar B, Schreiner K, Proctor A, Plume J, Hartling L. Virtual reality-based distraction for intravenous insertion-related distress in children: A study protocol for a randomised controlled trial. BMJ open. 2022;12(3):e057892.

13. Olbrecht VA, O'Conor KT, Williams SE, Boehmer CO, Marchant GW, Glynn SM, Geisler KJ, Ding L, Yang G, King CD. Guided relaxation–based virtual reality for acute postoperative pain and anxiety in a pediatric population: Pilot observational study. Journal of Medical Internet Research. 2021;23(7):e26328.