

SCOPING REVIEW

Application of virtual reality technology in nursing management: A scoping review

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Email: maojinbao@126.com**Abstract****Aim:** To summarize the application of virtual reality technology in nursing management, so as to provide reference for the further development of virtual reality technology in nursing management.**Design:** The design entails a scoping review using the methodological framework of PRISMA-ScR.**Methods:** A literature search was conducted using combined keywords in 2 English databases (PubMed, EMBASE) and 3 Chinese databases (Chinese Journal Full-Text Database, Wan fang Database, VIP Database for Chinese Technical Periodicals) of peer-reviewed publications covering the dates of publication from 2001 to July, 2021. Title and abstract screening and a full-text screening were conducted by two independent authors. Results were reported in accordance with PRISMA-ScR guidelines.**Results:** The search yielded 619 hits. A total of 17 journal articles met the inclusion criteria. We identified the following five themes: (a) innovate training mode and deepen theoretical knowledge, (b) non-invasive repetitive training to improve basic skills, (c) multiple virtual situations to help the development of the specialty, (d) standardize medical management and reduce potential safety hazards, (e) improve patient management based on holistic care.**Conclusions:** The paper points out that, the combination of virtual reality technology and nursing management is still in its infancy in China. Compared with foreign countries, there are few types of virtual situations in China, the depth and breadth of application research are insufficient, and the attention to nursing staff management ignores the spiritual level, which has a lot of room for improvement.**KEYWORDS**

application, nursing management, virtual reality technology

1 | INTRODUCTION

With the comprehensive and rapid development of informatization in the medical industry, emerging technologies such as the Internet of things, big data, and cloud computing have been continuously

integrated with traditional medicine, which has promoted the improvement of the medical service level (Pepin et al., 2017). Under the background of the information age, the nursing management mode has changed from the traditional paper and inefficient management mode to the information and intelligent management mode

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(Nardi & Gyurko, 2013). Virtual reality technology integrates computers, multimedia, simulation, and other disciplines. It can set virtual images according to the needs of users, and combine non-visual display methods to enable users to interact with specific situations. It has been more and more widely used in the military, aviation, medicine, education, entertainment, and other fields (Reymus et al., 2020; Rutkowski et al., 2020). This paper summarizes the application progress of virtual reality technology in nursing management, in order to analyse the current research status, and provide a new perspective and reference for making full use of virtual reality technology in nursing management in the future.

2 | BACKGROUND

2.1 | Basic concepts and characteristics

Virtual reality technology was proposed by Jaron Lanier in the 1980s. It uses multi-disciplinary technologies such as computers, multimedia, and simulation to generate an interactive and realistic three-dimensional virtual environment, which is characterized by immersion, imagination and interaction. Immersion means that users can immerse themselves in virtual situations in a variety of ways; Imagination means that users generate new imagination and obtain the corresponding perception in the virtual situation; Interactivity means that users interact with the situation with the help of sensors.

2.2 | Classification

According to different system functions, Virtual reality technology systems can be divided into four categories: desktop, immersive, augmented reality and distributed (Kim et al., 2017). The desktop type takes the computer screen as the virtual situation to build the window, and the user interacts with the situation by using the mouse, trackball, and so forth; Immersive uses the sensor tracking device to interact with the situation, which has the characteristics of high real-time and immersion; Augmented reality uses the virtual system to strengthen the feelings that cannot be perceived in the real environment; Distributed means that multiple users can observe and operate the same virtual environment at the same time.

According to different immersion levels, Virtual reality technology can be divided into three categories: immersion, semi-immersion and non-immersion. Among them, an immersive virtual reality system is the most common. The system can generate a specific virtual situation integrating vision, listening and touch. Users interact with the virtual scene through helmet-mounted displays, glasses displays, data gloves, tights and other necessary equipment, so as to achieve the feeling and experience equivalent to visiting the real environment (Moro et al., 2021). The semi-immersive virtual reality system uses a large screen display or multi-level high-performance graphics computing system for interaction, and its immersive experience is better than the non-immersive virtual reality system that needs to

manipulate the keyboard and mouse to deal with the stimulation of a three-dimensional environment.

3 | METHODS

3.1 | Study design

A scoping review methodology was used. The review was drafted using the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR, Tricco et al., 2018).

3.2 | Search strategy and eligibility criteria

A literature search was conducted using combined keywords in 2 English databases (PubMed, EMBASE) and 3 Chinese databases (Chinese Journal Full-Text Database, Wan fang Database, VIP Database for Chinese Technical Periodicals) of peer-reviewed publications covering the dates of publication from September 2001 (The earliest use of virtual reality technology in nursing) to July 2021. The exact search strategy for the databases is shown in Table 1. After the last search on 15 July 2021, the final search results were exported to EndNote X9®, and duplicates were removed.

Subsequently, papers were screened for title and abstract. The original study or abstract should contain a description of the application of virtual reality technology to nursing management. Only the application of virtual reality technology is carried out and articles or abstracts that are not relevant to nursing management are excluded. To enable including a large number of studies, only abstracts were considered. The researchers' hypothesis is that if an article explains the use of virtual reality technology in nursing management, it should at least be stated in the abstract. Figure 1 shows the selection process and results in a flow diagram according to the PRISMA reporting guidelines (Tricco et al., 2018).

3.3 | Data extraction and synthesis

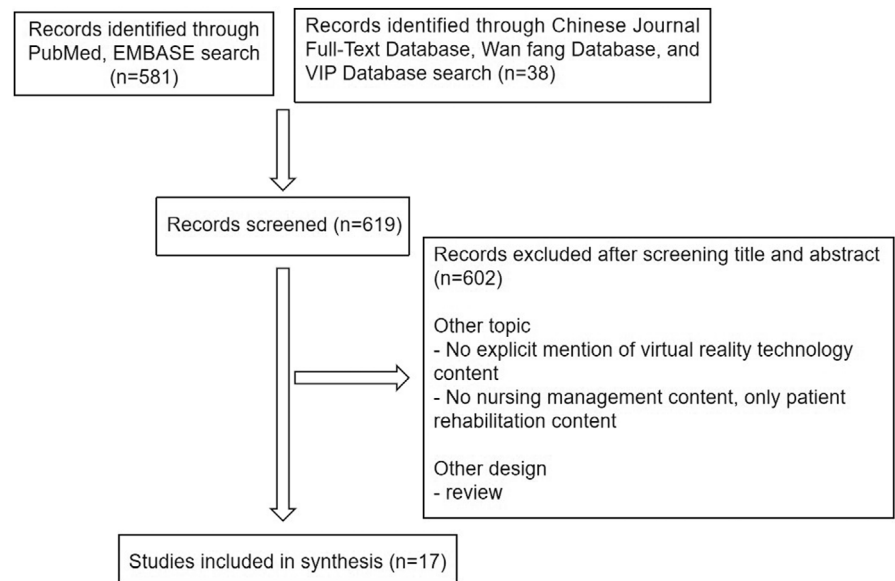
Data of included studies were extracted by all team members independently using a structured data extraction matrix and checked

TABLE 1 Literature search terms used for keywords^a.

No.	Keywords	Included
1	Virtual reality	Virtual reality, virtual reality exposure therapy, virtual reality technology
2	Nursing management	Nursing management, care management
1 AND 2		

^aThe following electronic databases were searched: PubMed, EMBASE, Chinese Journal Full-Text Database, Wan fang Database and VIP Database for Chinese Technical Periodicals.

FIGURE 1 Selection of sources of evidence.



by the first author as part of quality assurance. Any disagreements were resolved by consensus or by discussion within the team. General characteristics were recorded: author, VR technology used, skill or app., effect on nursing, and *p*-value.

3.4 | Data analysis

Studies have described the same or similar nursing management in different ways. In order to provide a manageable overview, comparable and similar activities were grouped together and the most inclusive terminology was chosen.

3.5 | Ethics

Ethical approval is not necessary because no human subjects and patient information were collected and studied.

4 | RESULTS

4.1 | Study selection

After duplicates were removed, a total of 619 citations were identified from the electronic database searches. Based on the title and abstract, 602 were excluded. The remaining 17 studies were considered eligible for this review and hence were included.

4.2 | Summary of the included studies characteristics

All eligible studies were published between 2001 and 2021, [Table 2](#) describes a summary of the included studies' characteristics.

5 | DISCUSSION

5.1 | Application of virtual reality in nursing management

5.1.1 | Innovate training mode and deepen theoretical knowledge

Virtual reality technology has great advantages in nursing training. Virtual reality can set up different simulation scenarios according to training needs, using simulation technology and immersion to immerse trainers in the situation. The virtual training system can analyse the operational records of the trainers, suggesting areas for improvement, with a clear feedback mechanism, innovating the training model, and providing managers with a training pathway.

5.1.2 | Non-invasive repetitive training to improve basic skills

Virtual reality technology provides a way to practice invasive operations. Virtual reality technology can provide non-invasive repetitive training and improve the operation skills of nursing staff. Intravenous infusion is a basic operation that clinical nurses must master. To effectively improve the puncture rate and reduce the injury to patients is the focus that nursing managers should pay attention to.

The virtual reality technology-assisted infusion training software can adopt 3D computer graphics, interactive external and external hardware control, and be connected to the desktop computer so that users can immerse themselves in the artificial environment, experience real-time sensory interaction, and all operation actions are automatically recorded for further analysis of operation effects. The virtual injection system can be adjusted according to the key points, principles and conditions of different injection methods. Nurses can make learning progress and goals according to their own learning

TABLE 2 The literature from 2001 to 2021 retrieved for the review on the application of virtual reality technology in nursing management.

Application of virtual reality in nursing management	Author, (year)	VR technology used	Skill or app	Affect it on nursing	p-value
Innovate training mode and deepen theoretical knowledge	Liaw et al., (2020)	Computer-based virtual reality	CREATIVE (Create Real-time Experience and Teamwork in Virtual Environment), where users can create physical and social presences using avatars in a 3D virtual hospital environment	Future studies can leverage the use of artificial intelligence technology in virtual reality to replace costly human-controlled facilitators to achieve better scalability and sustainability of team-based training in interprofessional education	0.29
	Dyer et al., (2018)	Virtual reality simulation	Embodied Labs (EL)	The project successfully introduced an innovative new teaching modality to the medical, physician assistant, physical therapy and nursing curricula. Results show that VR enhanced students' understanding of age-related health problems and increased their empathy for older adults with vision and hearing loss or Alzheimer's disease	—
	Rong, (2019)	Analogue simulation	SimMan's Virtual Experiment Platform	Rational application of virtual reality technology in surgical nursing teaching can promote students' independent learning, and help students develop better clinical adaptability, analysis and judgement ability	<0.05
	Ruijie and Wen, (2020)	Equipment for three-dimensional imaging and pressure feedback	Virtual software for intravenous injection developed by Leardal	Innovate the teaching mode of paediatric nursing and improve students' practical ability	—
Non-invasive repetitive training to improve basic skills	Tsai et al., (2008)	3D computer graphics, interactive circumscribed and external hardware controls	VR simulation system of Port-A cath injections	VR simulation significantly reduced error rates and increased correct equipment selection, showing that nurses who participated in the simulation may be better prepared for inserting Port-A cath	<0.05
	Mi Tian & Wang, (2016)	Virtual reality simulation	Virtual experiment platform	Virtual reality technology can strengthen students' operation and application skills of basic nursing technology, and cultivate students' ability to analyse, summarize and judge problems	<0.05
	Choi, (2017)	Virtual reality simulation	NGT placement training simulator	Taking advantages of the VR technology, the novel NGT placement training simulator provides an automated and standardized method that can increase the learning opportunity and enables asynchronous self-learning	—
	Ping et al., (2020)	Virtual reality simulation	Virtual training system for venipuncture	Immersive virtual reality technology improves students' mastery of experimental operation content, and students are satisfied with virtual experience	<0.05
Multiple virtual situations to help the development of specialty	Paschold et al., (2017)	Virtual reality simulation	Virtual reality laparoscopic (VRL) simulator	With VRL simulator training, nurses, students, and first year residents are equally capable of assisting in basic laparoscopic procedures	<0.05
	Lin et al., (2020)	Computer-based virtual reality	VR nursing emergency drill system	Virtual reality technology coagulation emergency plan training system helps to improve nurses' responsiveness and emergency handling ability when encountering unexpected events in clinical work	—
	Nicely & Farra, (2015)	Virtual reality simulation	Virtual reality simulation based upon disaster management and triage techniques	Collaborative creation of the simulation proved to be a strategy for enhancing students' knowledge of and skill in disaster management and triage while impacting attitudes about interprofessional communication and teamwork	<0.05

TABLE 2 (Continued)

Application of virtual reality in nursing management	Author, (year)	VR technology used	Skill or app	Affect it on nursing	p-value
Standardize medical management and reduce potential safety hazards	Dubovi et al., (2017)	Virtual reality simulation	Pharmacology Inter-Leaved Learning Virtual Reality (PILL-VR) simulation	VR simulations may provide affordable and flexible access to practice necessary practical skills in higher education, which is crucial to developing students' expertise	<0.05
Improve patient management based on holistic care	Halicka et al., (2021)	Binocular dichoptic visual therapy	Oculus Rift virtual reality helmet	The preliminary results of this case show the potential of using virtual reality-based visual training as a treatment for adult amblyopia	<0.05
	Tejera et al., (2020)	The hypoalgesic effects of distraction by VR	Fulldive VR, VR Ocean Aquarium 3D	Immersive VR showed to be a more effective tool for reducing the pain-related fear of movement in NS-CNP	<0.01
	Hao & Dongdong, (2020)	Virtual scene interaction training	Bio-master Virtual Training Evaluation System	Whole body vibration therapy combined with virtual scene interaction training can significantly improve the balance function, gait and proprioception of hemiplegic patients after stroke	<0.05
	Lee et al., (2020)	Virtual reality simulation	VR simulation using 360-degree videos and HMDs	The findings indicate that VR-simulated scenarios of patients with schizophrenia involving 360° videos and HMDs have considerable potential to improve treatment competency among mental health nursing students	<0.05
	Sihui et al., (2020)	Virtual reality cognitive training	VR Cognitive System Attention Training System	VR attention training may be more beneficial than CCRT attention training to improve the attention among depressive patients	<0.01

conditions, and further improve the injection method goals at each stage, which is conducive to improving the clinical operation ability.

5.1.3 | Multiple virtual situations to help the development of specialty

Virtual reality technology can simulate different virtual situations. At present, nursing training scenarios mainly involve the development of specialty and the improvement of emergency response ability. For example, virtual reality technology can combine a virtual reality system with laparoscopic-assisted operating room nurse training, use a virtual reality laparoscopic (VRL) simulator, use 'camera navigation', 'nail transmission' and 'fine anatomy' simulators to cooperate with simball 4D joystick for surgical training. In order to improve the emergency response ability of nurses, virtual scenes can be set up through virtual reality technology, such as integrating disaster management and classification technology and designing disaster scene simulation training. Through the collaborative development of virtual scenes, nursing staff can accurately grasp emergency priorities, master relevant knowledge, and further understand role cognition.

5.1.4 | Standardize medical management and reduce potential safety hazards

Dubovi et al. (2017) used virtual reality technology to simulate the medical management program and design different execution

situations. Nursing students and nursing staff can practice the medical article management operation through the program, and carry out correct drug selection and accurate drug dose distribution according to the patient information and doctor's orders provided in the simulation program. After patients take drugs, manage the patient condition by monitoring and treatment evaluation after medication. If the learners make a wrong operation, the management system will appear message prompt and correct demonstration. Through virtual reality simulation, we will deepen the familiarity of nurses with the concept of drug management and corresponding procedures, so as to further improve the competence of nurses in medical management.

In China, virtual reality-related research is rarely applied to the management of medical articles by nursing staff, and the attention in this regard needs to be improved.

5.1.5 | Improve patient management based on holistic care

Through literature retrieval, we found that virtual reality technology has been gradually applied in the process of patient management, and has greater advantages. At present, the research and development of virtual reality technology mainly involve rehabilitation nursing and psychological nursing of patients.

Halicka et al. (2021) paid attention to the patient handover link and introduced the virtual reality system into the patient handover program. In order to ensure the interaction between the virtual program

and the real world, they studied the use of all-round video recording to create a virtual situation and enhance the sense of space of the application, realize the multi-user training of virtual reality prototype and the handover of examination application patients; the research and development of virtual reality procedure for patient handover in China is relatively blank, so it should be focused in the future.

5.2 | Limitations

The following limitations should be taken into account when interpreting the results of the current scoping review. To enable including a large number of studies, only abstracts were considered. Therefore, some excluded studies may also mention the application of virtual reality technology in nursing management in the full text, but do not pay attention to them.

6 | CONCLUSION

With the development of artificial intelligence, the combination of virtual reality technology and nursing management is improved. In foreign countries, the application of virtual reality technology in nursing management is relatively mature, the levels involved in nursing management are relatively rich, and the types of virtual situations designed for management are relatively perfect. At present, the direction of the combination of virtual reality technology and nursing management in China is mostly limited to nursing education and patient management. The depth and breadth of research on medical management and specialized nursing need to be improved, and the attention to nursing staff management ignores the spiritual level. There is a lot of room for the development of virtual reality applications in China.

AUTHOR CONTRIBUTIONS

Methodology, and investigation: Zhenya Zou, Qian Gao, Xiaoyang Zhou and Hongxiang Duan; Validation and writing-review and editing: Zhenya Zou, Qian Gao, Jinbao Mao; Writing-original draft preparation and formal analysis; Xiaoyang Zhou, Hongxiang Duan; Supervision: Jinbao Mao. All authors have read and agreed to the published version of the manuscript.

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CONFLICT OF INTEREST STATEMENT

The authors declare that there is no conflict of interest.

DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

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