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Extended Reality Is Underutilized in Medical Device Training: A Descriptive Literature Review

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Abstract. This descriptive review provides a synthesis of existing literature about the use of extended reality (XR) including virtual (VR) and augmented reality (AR) technology solutions for competence assurance, training and orientation regarding digital skills and medical device training. From the literature, only few original studies were recognized with a study question or aim to assess medical device training as the target of virtual training modalities. XR methods could provide potential useful solutions to improve medical device competence. Based on the literature, it was evident that further studies are required to research the possibilities of XR technologies to improve medical device training.

Keywords. Medical device, patient safety, augmented reality, virtual reality

1. Introduction

Safe and competent use of medical devices in patient care is of paramount importance to both the patient and the medical staff [1, 2]. Despite a clear need for training and orientation to improve medical device safety, there are major challenges how to acquire and provide sufficient education [3]. In Europe, the European medical device legislation has been renewed and the Medical Devices Regulation (Regulation (EU) 2017/745) has been in effect since 26 May 2021. In Finland, the legislation concerning medical devices (Finlex 629/2010) defines the responsibilities of the professional user, as well as the responsibilities of the employer to ensure adequate competences of the staff. Medical device training and orientation need to be more effective in order to ensure a sufficient level of health technology and medical device skills among health care personnel. Since training and orientation is challenging during working hours, it is necessary to develop new types of pedagogical extended reality (XR) solutions including virtual (VR) and

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augmented reality (AR) technology for digital and medical device competence assurance, training, and orientation. Aim of this study was to assess how extended reality technology has been utilized in medical device training to enhance learning and patient safety.

2. Methods

As part of the Virtual Platform for Medical Device Training project, the published scientific literature was analysed in order to describe the status quo of the XR solutions for training and learning health care technologies. The aim was to identify studies focused on medical device safety in health care, including hospital based, home care, and social welfare sector. The purpose of this review was descriptive.

The literature search was performed initially between October and November 2021 and a complementary search was performed in March 2022. The search was performed using Medline, PubMed and Google Scholar and Google. In addition, searches were completed from the reference lists of the detected articles. There was no time limitation. English, German, French and Scandinavian languages were included.

One researcher (TI) went through the relevant headings and abstracts and selected the full text articles for reading to other members of the review team. Each member was allocated a subheading for analysis of the literature. The focus was on the effect of immersed technologies on learning of skills required for safe use of medical devices.

The following search phrases were used in various combinations: virtual reality, augmented reality, extended reality, teaching, education, learning, medical device, medical device safety, medical device training, learning of medical device safety, medical equipment, medical device safety learning, medical device training simulation, review.

PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow chart was used, although the study did not fill all other PRISMA requirements.

3. Results

The search protocols and the number of abstracts and full text articles are described in Figure 1. Altogether 1375 headings, and of those 48 abstracts of interest were found. The authors performed complementary searches while writing the descriptions. Four articles were added to the review material as result of complementary search during writing the review. In total 31 full text articles and two theses were read and five abstracts of interest were included even though full text was not available.

The review confirmed that extended reality training modalities are already being used as a part of health care education in nursing, medical, dental, and paramedic education. Simulation offers a safe environment for training different skills and for learning from mistakes. The attitudes towards training are mainly positive in the field on health care. Simulated authentic patient situation is considered the most motivating training [4].

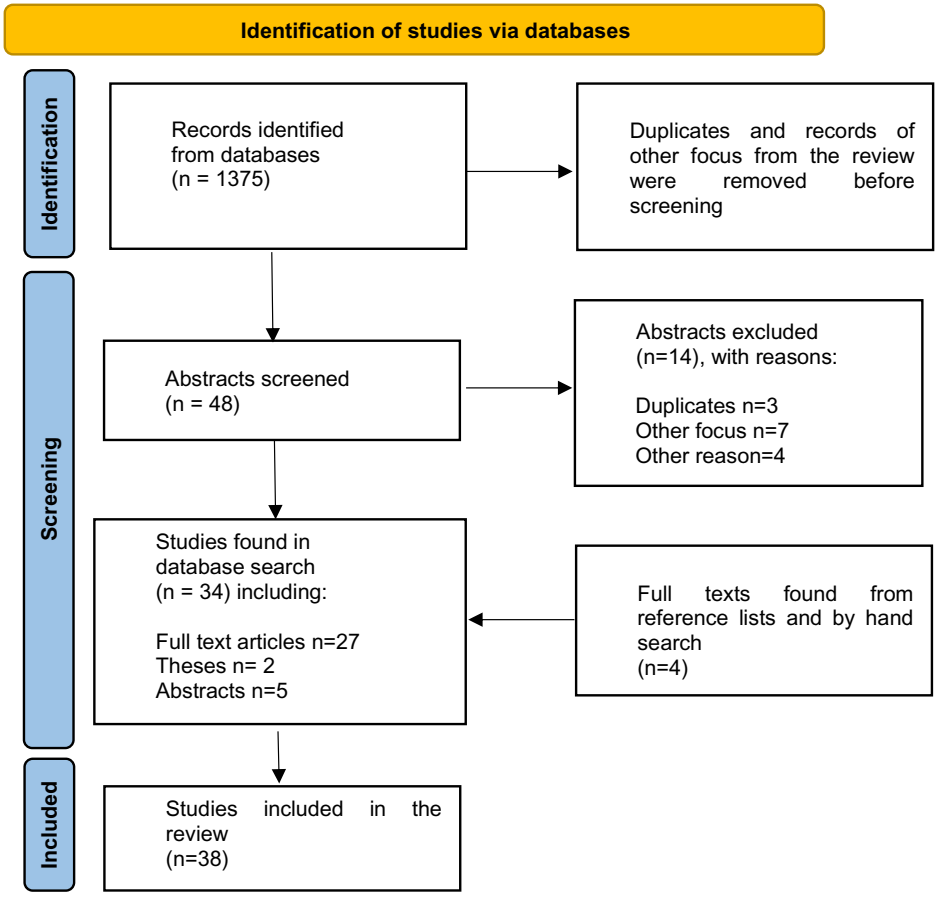

Figure 1. PRISMA flow chart for presenting the selection of literature.

Typically, medical or surgical procedures formed the majority of trained techniques, such as neurosurgery, gastrointestinal surgery, orthopedic surgery, dental surgery, surgical ophthalmoscopy, gynecology, surgical knot training, and peg tube, central line and catheter insertion. Anatomy teaching and emergency medicine decision-making skills were trained, as well.

VR technology was also being used in the fields of leadership, communication, decision making, critical thinking, inclusivity, health appraisal and disaster triage [5]. VR assisted learning methods were more effective than the control conditions in improving knowledge, but there was no difference between skills, satisfaction, confidence, or performance time [5].

It was concluded that online simulation training provides a virtual hands-on experience in advance of implementing new equipment and coupled with adult learning

principles, may enhance the experience of clinical end users of technology. Especially in home environment, augmented technology will add skills to manage safety hazards [6].

Although VR technology is developing rapidly, the immaturity on the technology can cause challenges to the students' ability to transfer "hands-on skills" from VR environment to reality [5]. AR seems to be more effective in supporting skill development rather than knowledge gain when compared to other techniques [7].

Immersive experiences may foster the teaching and learning of complex medical contents. Head mounted devices (HMD) including a headset or glasses are versatile, low-price, and mobile, and make learning content more accessible and engaging [8, 9]. The training with HMDs were shown to improve practical skills, reduce stress, and gain self-confidence for the actual procedure. The main benefits of studies have shown decreased surgical error rates, cost-effectiveness, and improved knowledge [8, 10]. VR training also increased confidence and reduced anxiety, and training improved measured understanding, technical skills and immersed efficiency [11].

Not all studies reported effective outcomes for the use of HMDs in medical education. The disadvantages of HMDs were motion sickness and nausea, technical problems, and stress. These may impede learning and training. It is unclear if symptoms of motion sickness and nausea are related to beginners or if they tend to persist and affect learning. Women more often suffer from motion sickness using VR devices. As AR devices combine real and virtual environments, they seem to mitigate negative health effects such as blurred vision, disorientation, and cybersickness [8, 10].

Although improved medical device skills are linked to patient safety, only one study described training of safety during medical device usage as the main purpose of the study. The use of virtual training for fire prevention was investigated while using electrocautery device. The authors concluded that training for operating room fire emergencies in fully immersive VR environments may be the ideal training modality [12].

4. Discussion

Based on the current literature, only few original studies were recognized with a study question or aim to assess medical device training as such, as a target of extended reality training modalities. Majority of the studies were not about how to use the medical device, but were simulations of procedures and about learning operative or procedure skills.

The teaching methods based on the utilization of XR in health care education are used somewhat integrated with more traditional teaching methods. The use of virtual technologies is increasing and being developed to be more user friendly. Cost efficiency and relative independence from time and place are being identified as advantages of using extended reality in learning. Such technologies offer the possibility of scalability and repeated practice without adverse effects on the patient.

The majority of studies included in this review considered extended reality based intervention as at least non-inferior to the traditional teaching methods. Even though such training methods have been reported as an engaging and enjoyable tool for learners to improve their knowledge and skills, a considerable proportion of users suffer from physical adverse effects of the technology that might impede learning. Usability and availability of the technology and the adverse effects experienced by the user are seen as the challenges of using virtual technologies in teaching.

The limitations of the review include some shortcomings of the full commitment to PRISMA checklist. For example, the risk of bias was not assessed for the selected articles,

and the numbers of participants were not counted. Apart from searched databases, there might be other databases containing virtual training publications. Due to time limitations, only one researcher read the headings and abstracts. Each author did the analysis and writing mainly independently, which might be seen as a limitation to the review.

5. Conclusion

The reviewed original studies posed positive expectations to extended virtual technologies as a solution for educational and training requirements concerning medical devices. Future studies are required that focus on teaching the safe use of health technologies in order to maximize patient safety. The benefits of XR solutions in learning medical device safety have not yet sufficiently researched. Thus, more studies are needed.

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