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Concise Communication

Playing the long game: virtual reality training for standard precautions in long-term care

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Abstract

Five long-term care facilities trained healthcare personnel ($N = 34$) on a 30-minute virtual reality (VR) training module on core infection prevention and control competencies. Semi-structured interviews and surveys showed strong engagement and participant enjoyment. Performance data from head-mounted displays revealed areas for improvement, highlighting VR's potential to enhance competency-based training.

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Introduction

Healthcare-associated infections (HAIs) are associated with negative patient outcomes and higher costs of care. Long-term care facilities (LTCFs) face inherent challenges preventing HAI, including a population facing higher risk of infection due to underlying medical conditions, the use of invasive devices, and environmental factors.[1] Virtual reality (VR) training provides the opportunity to visualize contamination in the healthcare environment.[2,3] Immersive VR can generate a sense of presence and agency for learners,[4] engaging the cognitive, affective, and kinesthetic domains of learning.[5] Though VR has demonstrated promise in healthcare personnel (HCP) training in acute care,[5,6] assessment in LTCFs remains limited. This quality improvement project aimed to evaluate the usability of immersive, gamified VR-based training for standard precautions in LTCFs and the use of head-mounted display (HMD) data to capture infection prevention and control (IPC) performance.

Methods

A multidisciplinary team of IPC and other clinicians, instructional designers, and VR developers created a VR module, "IPC Foundations," focused on standard precautions, including gamified identification of infection risks in the environment (Figure 1). HCPs were recruited from five LTCFs to test the module. A semi-structured interview guide was developed by the project team with guidance from an experienced qualitative researcher. Following the completion of interviews at the first site, the interview guide was shortened, and a survey was developed. Participants from subsequent pilot sites each completed a 15-minute interview and a 24-item survey. Double-thematic coding of verbatim interview transcripts was independently performed. Survey data were collected and managed using REDCap (Research Electronic Data Capture) electronic data capture tools hosted at Mass General Brigham.[7,8] Surveys were analyzed using descriptive statistics.

The VR module assessed participant awareness of infection risks in their environment by simulating a realistic setting with several concurrent tasks participants needed to complete. Participants could see their score increasing as they identified each infection risk. At the end of the module, the total possible score was revealed, and participants could keep looking before completing the module. Analytics were collected directly from the HMDs on the duration of VR sessions, completion of the module, and participant performance on identification of infection risks and hand hygiene (HH) compliance. The VR module was designed with alcohol-based hand rub dispensers and sinks placed in appropriate locations on the simulated unit and to prompt HH when it was missed through pop-up alerts. HMD data were excluded if incomplete due to poor Wi-Fi connection interrupting transmission of HMD data to the cloud-based analytics system.

Upon completing the interview and survey, participants received a $50 gift card for their time.

The study received Non-Human Subjects Research (NHSR) determination by the MGB Institutional Review Board (2023, ID 863).

Results

Between March and May 2025, 34 participants from five LTCFs completed the VR module, preceded by a short tutorial on the use

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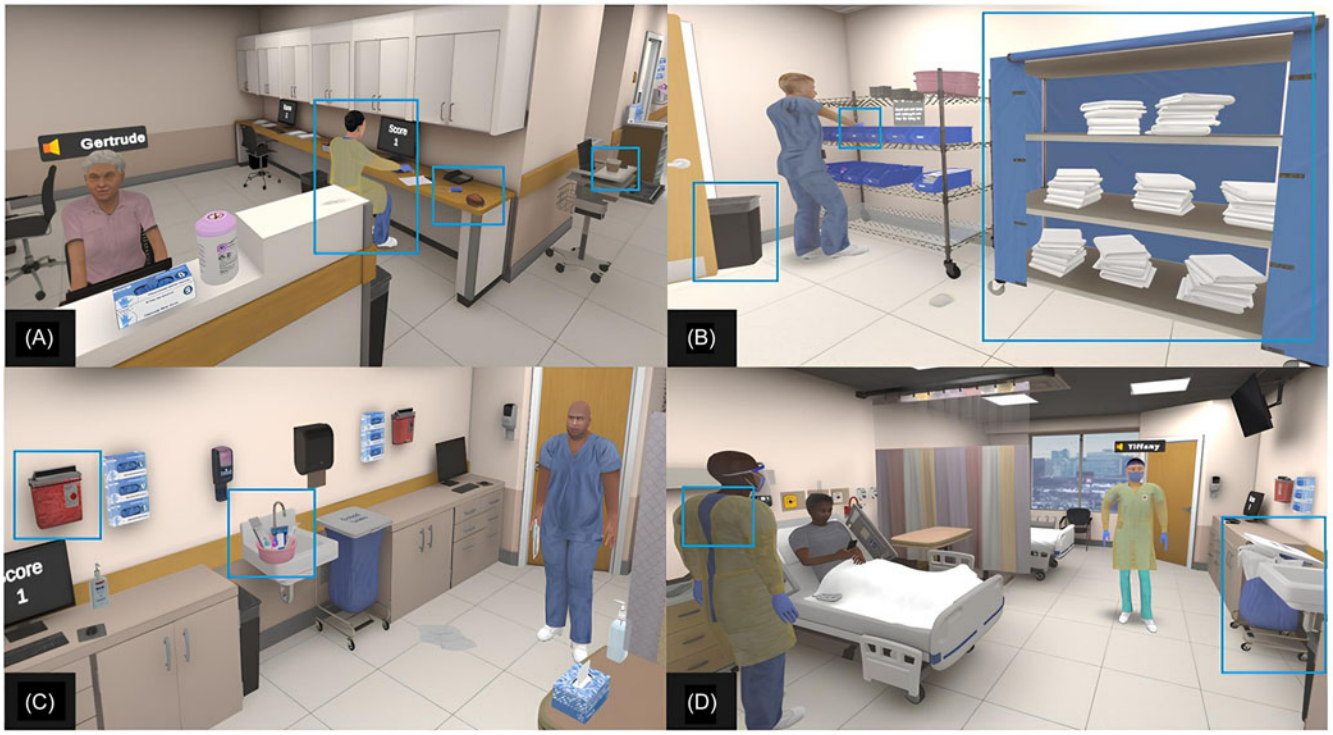


Figure 1. Representative infection control risks encountered in the VR module. A. Learner cleans and disinfects the workstation and may identify the infection risks: a discarded face mask and food, a colleague wearing a gown and gloves on a workstation, and an uncovered beverage on the workstation on wheels. B. In the clean utility room, the learner retrieves supplies and may identify the infection risks: a trash can propping open the door, a colleague wearing gloves while retrieving supplies, and a linen cart left open. C. In the first patient room, the learner picks up the dirty linens on the floor and may identify the infection risks: an overfilled sharps container and a personal care basin on the sink. D. In the second patient room, after donning personal protective equipment, the learner assists a colleague with care and may identify the infection risks: a colleague with an untied isolation gown and the overflowing soiled linen bin. The module was developed using the EducationXR application (Heizenrader LLC, Salt Lake City, UT) and used with HMDs (Meta Quest 2 and 3, meta, Menlo Park, CA). A short video of the module can also be viewed in supplementary material.

of VR controllers. All participants were included in the interview analysis, and 29 participants in the survey analysis. Twenty-seven participants were included in the HMD data analysis (Supplementary Figure 1). Participants ranged in age from 19 to 60 years; the majority worked in nursing (15/34, 44%) or were nursing assistants or clinical support staff (13/34, 38%) and reported minimal to no prior VR experience (31/34, 91%).

Six themes were identified (Table 1). Participants highlighted engaging with non-playable characters (NPCs) and identifying potential infection risks boosting their training scores as key aspects of the experience. Most participants (31/34, 91%) reported learning something new or receiving a refresher on key points, including specific infection risks, and the importance and recommended frequency of HH. Participants reported they felt enjoyment (21/34, 62%), excitement (16/34, 47%), and curiosity (14/34, 41%) as they navigated the VR module, and frustration (14/34, 41%) with using the controllers and performing certain tasks.

Participants reported that the VR module was more engaging than previous IPC trainings (mean 4.46 on a 5-point Likert scale, SD .69). Participants noted they would recommend the VR module to other HCP in similar roles (mean 4.24, SD .91). Complete survey results are provided elsewhere (Supplementary Table 1).

Participants spent a mean of 32.6 minutes in VR, including 3.7 minutes in the tutorial. Out of 28 assigned training tasks, participants did not complete a mean of 2.78 tasks. Participants identified a mean of 9.74 out of 16 infection risks. Items at the workstation were the most frequently identified infection risks (24/27–26/27, 89–96%, Supplementary Table 2). The most missed infection risks were use of gloves in the clean utility room (5/27, 19%), an untied isolation gown (7/27, 26%), and an overfilled sharps container (7/27, 26%).

As learners could navigate the virtual space independently, the total number of hand hygiene opportunities (HHOs) varied by user. A mean of 2.56 HHOs were missed during the VR module, with most participants (23/27, 85%) missing at least one HHO. Participants most often missed HH when entering a patient room the first time (12/27, 44%) and when leaving a patient room the second time (12/27, 44%). Only 15% (4/27) of participants had perfect HH compliance. For 22% (6/27) of participants, a one-time HH reminder was followed by HH compliance for the remainder of the VR module.

Discussion

Growing evidence demonstrates high levels of learner engagement and satisfaction with VR as a training modality.[6] Consistent with current literature, participants in this study largely praised the VR module, despite some experiencing frustration with new technology.

VR also allows for live skills assessment, real-time feedback, and repeated practice.[3] Participants most often identified infection risks in the beginning of the module, immediately after one of the NPCs advised to look out for them. Common misses occurred toward the end of the module. This could be due to cognitive fatigue from being in the VR module, or participants may not have recognized some elements as infection risks (Table 1).

Participants also received real-time feedback on missed HHO. Most participants reported that the pop-up HH reminders were a

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Table 1. Themes and illustrative quotes from semi-structured interviews

Theme	Description	Quotes from participant interviews
1	Participants enjoyed interacting with NPCs, identifying infection risk, and performing tasks	When Gertrude [NPC]-I remember her name—when she was talking—just to have, I mean, feel like somebody was right there talking to you. And I think that was interesting and something different. Finding everything, that was fun. I loved it. I really wanted to get all of them because I'm pretty competitive.
2	Participants felt frustrated or struggled with glove donning and doffing, and navigating using the controllers	I struggled at first to put the gloves on and then figured it out. Honestly, it was kind of hard to focus on the lessons because I was just trying to figure out the VR process. So, in some ways, that distracted from the actual training.
3	Participants forgot to look for infection risks while performing assigned tasks	I do like that you guys had the hidden germ things or other safety precautions or whatnot. It was just hard to do. And they're telling you to do all the tasks on one side . . . So I felt like I was very task-oriented of being like, Yeah, I need to pick up this, this, and this, . . . [so] I completely forgot about—not forgot, but didn't really look for the other safety things that click off . . . But if I did see something, I would, in real time, do that, also pick it up. But yeah, when [NPC is] talking to you a lot, I feel like you get really task-oriented of being like, I need to do this, this, and this, instead of seeing all the small little stuff that you might miss.
4	Participants increased awareness of PPE donning order, HH practice, and infection risks.	I guess, just a good refresher. I do it every day, but just really realizing the steps of how to put everything on because I feel like sometimes you get in a hurry and you're just like, Yeah, I'm getting everything on, and it might not be the safest or cleanest way. I guess I just really kind of forgot how often we are really supposed to be washing our hands, sanitizing our hands. I wouldn't even have thought about the fact of the sharps container being an infectious control thing. So I did learn about that.
5	Participants recommend VR for younger and newer healthcare staff	I think it's a really great tool. I think it's a great way to put someone, especially new nurses, into an environment, to teach them on what infection prevention should look like instead of just throwing them into the fire pits and saying, Okay. Figure it out. You learned this in school, but now you got to figure it out. I think it would be a mixed bag, honestly, because you have a lot of older people who work here. And I mean, older as in like 45 and above, who probably don't have a whole lot of experience with just video games, period, and especially not VR . . . And I think that those older people, it would be really hard to get them to acclimate to something like that.
6	Participants reported that the VR module was more engaging than previous IPC training due to its hands-on nature.	I'm an audio-visual learner, so if you can throw in some interactive opportunities in there, I love it. So I think, for me, at least, this type of training would be effective and kind of fun. [In previous IPC training] you watch videos and then you take little quizzes throughout. And then I think at the end, there's like a bigger quiz. And if I'm being honest, it's pretty easy to just skip through the videos and then take the quiz. And then if you get it wrong, you can redo it. . . . and they're kind of boring. And then the quiz—I mean, most of the stuff I know. If you were to ask me a lot of the things yesterday, I would have been able to give you the right answer. But it's like when you're doing it in the virtual reality, you realize the things are like, if you knew on paper, you'd say yes. You'd just kind of go over your head in real life. So it made me actually think more about infection control and reflect on my own practices than just watching some videos and answering some questions really quick that don't make you think deeply about how you actually do it.

NPC: non-playable character; VR: virtual reality; PPE: personal protective equipment; IPC: infection prevention and control; HH: hand hygiene.

good refresher; the majority (23/27, 85%) had to be reminded to perform HH during the training with very few adhering to HH throughout. It appears that participants, while focused on the assigned tasks in the module and navigating new technology, frequently forgot this crucial IPC practice.

Despite the potential for increased learner engagement and satisfaction, technical and logistical challenges remain. During the study, power outages, poor Wi-Fi connection, and HMD location tracking malfunctions were observed. Limitations of this study include the technical challenges described above, as well as a small sample size.

VR is increasingly used in clinical training; however, efforts to implement VR IPC training in LTCFs have not, to our knowledge, been evaluated. Current literature on VR in LTCFs focuses primarily on its therapeutic use for residents.[9] This study identified HCPs' perceived high value of VR for IPC training, especially with respect to the VR module's immersion, interactivity, and gamification. VR training can be utilized to collect performance data from HMDs, as was done in this study, to inform supervisors' or organizations' improvement efforts. Integration of real-time performance analytics to ongoing competency assessments may

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enhance IPC trainings and learner satisfaction, particularly when coupled with adaptive feedback or targeted retraining. Future efforts should focus on scaling and refining VR modules across diverse LTCFs and addressing technical challenges to support broader adoption. Additional research is needed to evaluate retention, long-term outcomes, cost-effectiveness, and the integration of VR with traditional educational methods in IPC.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/ash.2025.10239.

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