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WHAT'S NEW IN INTENSIVE CARE

Virtual reality in intensive care

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A tool for the intensive care unit emerging from the entertainment industry

Virtual and augmented reality (VR/AR) are becoming increasingly familiar to us from science fiction and are now commonly used for entertainment. In VR, the user wears special glasses to immerse them entirely into an artificial three-dimensional world (VR) or to integrate different imaging modalities superimposing virtual elements into a real-world environment (AR). For VR, various applications are helpful in intensive care medicine for healthcare providers, patients, and their relatives: education, training and relaxation [1]. Accumulating evidence suggests that VR will find its role in the intensive care unit (ICU), although large studies are currently lacking [2, 3]. Figure 1 illustrates some potential roles for VR in the ICU: to train ICU staff to perform practical procedures or to setup up devices (A) or to distract and comfort patients during procedures (B). In addition, VR could help to alleviate delirium and anxiety (C), and improve mobilisation and weaning. At present, it is challenging to delineate the "real" evidence for VR use in intensive care medicine. This brief overview presents the available and emerging options and the latest evidence.

Virtual reality for the healthcare provider

VR can be used to support the simulation of complex medical procedures or emergency scenarios [4]. Although its opportunities and advantages are clear, no randomised trials have been published to date. VR might also offer ICU staff new opportunities to improve well-being and chronic fatigue at work: Bodet-Contentin et al. included an 8-min-long VR session in the usual break in 88 ICU staff members. VR significantly reduced fatigue and led to a significantly higher sense of disconnection from the work environment [5]. Nijland et al. offered ICU nurses an immersive 10-min-long VR session during their shift. This resulted in a lowered perceived level of stress [6].

A non-pharmacological way of treating anxiety, stress, and pain?

Stress and anxiety play a significant role in ICU patients. Since pharmacological interventions can have adverse effects, non-pharmacologic interventions such as VR are becoming increasingly important. Jawed et al. studied the use of VR in 15 ICU patients for 15 min and exposed them to relaxing videos. Most patients tolerated the application well and reported positive effects on anxiety and stress [7]. Rousseaux et al. in a randomised controlled trial of 100 patients, tested the use of "virtual reality hypnosis" in patients one day before and one day after cardiac surgery. In this small study, there were no significant differences with regards to the outcome measures (anxiety, pain, fatigue, relaxation, physiological parameters, and opioid use) [8]. A randomised controlled trial of 48 patients evaluated the positive effects of VR on the quality of sleep in ICU patients: VR resulted in a significantly better sleep quality, although total sleep time and light sleep time did not differ between the groups [9]. Laghlam et al. evaluated the use of VR in 200 patients undergoing chest drain removal after cardiac surgery. Compared to inhaled nitrous oxide, VR was associated with a higher pain score immediately after drain removal. However, for pain levels reported ten minutes after removal, VR was non-inferior when compared to pharmacological treatment [10]. In another study by Ong et al., 59 patients received meditative VR which focussed on calmness and relaxation. VR was performed once daily for up to 7 days. VR led to reduced subjective levels of anxiety and depression

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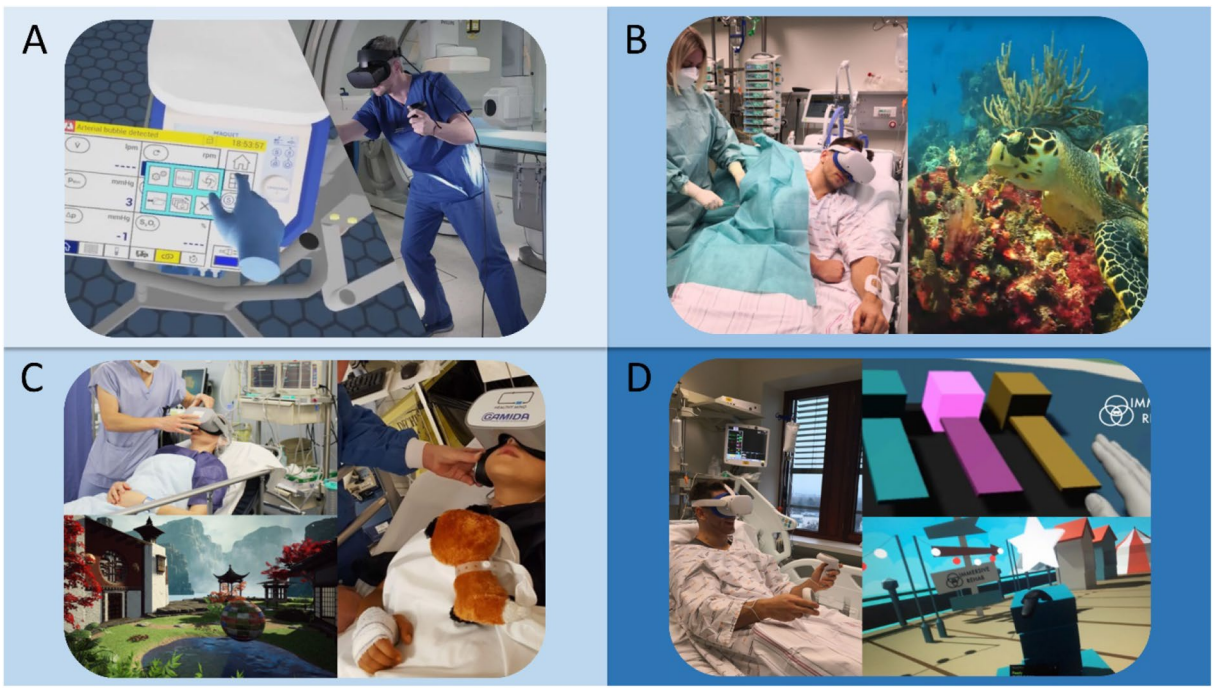

Fig. 1 Virtual reality in practical intensive care medicine

without significant effects on physiological measures, pain, or sleep. Six patients developed delirium, although the authors found no connection with using VR [11]. Aside from immersive VR, neurocognitive virtual stimulation may improve cognitive and emotional outcomes in mechanically ventilated critically ill patients. Navarra-Ventura et al. randomised 72 critically ill patients. One month after ICU discharge, patients who underwent early neurocognitive VR evidenced higher working memory scores and less anxiety and depression than the control group [12].

A new tool against the "post-intensive care syndrome"?

Many patients are diagnosed with post-intensive care syndrome (PICS) after ICU treatment, experiencing mental health issues, cognitive dysfunction and problems with mobility. More information about ICU treatment might be helpful, because conventional methods, such as information brochures, are not well accepted or utilised [13]. Vlake et al. recruited 104 patients who survived sepsis or septic shock and used informative VR modules (e.g. providing information about the treating team and ICU workflow) 3 and 6 months after ICU treatment. 57 ICU patients were treated with VR and 47 patients were randomised to the control group. The control group also received VR, but were shown a relaxing virtual reality environment instead of information about ICU. VR providing information reduced post-traumatic stress disorder and depression scores. Interestingly, this effect was still present for post-traumatic stress disorder and depression, but not for mental quality of life, six months after VR exposure. In terms of safety, cyber sickness scores were low and no changes in vital signs were observed [3]. By contrast, another study that focussed on coronavirus disease 2019 (COVID-19) ICU survivors found no effect of providing VR information on psychological recovery or quality of life [2].

Persisting issues in VR studies

Although the number of studies involving VR is growing significantly, systematic reviews and meta-analyses are challenging as the methods used, devices and protocols are difficult to compare [14]. Using VR can cause a syndrome called "cyber sickness", where people experience headaches, nausea and vomiting. Pathologically, this syndrome is probably caused by motion-induced sickness [15]. Finally, there is no evidence about the risk of VR glasses in patient-to-patient transmission of infections such as multi-drug-resistant pathogens.

VR will become an important tool in the ICU. Potentially, promising applications from the patient's perspective are additional sedative and analgesic effects, more detailed information about ICU treatment, and early cognitive and physical training. AR might also allow

healthcare providers to learn and enhance their skills in complex intensive care procedures. To date, evidence is still scarce, and there is a lack of large-scale randomised controlled trials. The quality of evidence from clinical trials needs to evolve from virtual to reality.

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Declarations

Conflicts of interest
The authors declare that they have no competing interests.

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