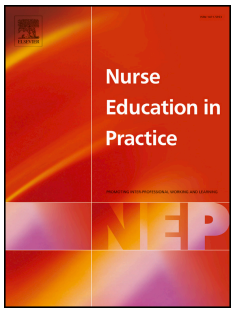
Accepted Manuscript



Consideration of using virtual reality for teaching neonatal resuscitation to midwifery students

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PII: S1471-5953(17)30805-3

DOI: 10.1016/j.nepr.2018.05.016

Reference: YNEPR 2409

To appear in: *Nurse Education in Practice*

Received Date: 12 November 2017

Revised Date: 4 May 2018

Accepted Date: 27 May 2018

Please cite this article as: Williams, J., Jones, D., Walker, R., Consideration of using virtual reality for teaching neonatal resuscitation to midwifery students, *Nurse Education in Practice* (2018), doi: 10.1016/j.nepr.2018.05.016.

CONSIDERATION OF USING VIRTUAL REALITY FOR TEACHING NEONATAL RESUSCITATION TO MIDWIFERY STUDENTS

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Acknowledgements: Nil

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors

Considerations of virtual reality simulation to teach neonatal resuscitation to Australian midwifery students

Abstract:

Within the last decade, there has been significant change in the way tertiary midwifery education has been delivered to students. The use of blended teaching methods and the introduction of simulated learning experiences has been observed in the literature to improve students' self-confidence, competence, clinical judgement and decision-making abilities. Simulation is seen to be particularly important when practising skills that may be infrequently encountered in practice, such as clinical emergencies. Neonatal resuscitation is the most common neonatal emergency encountered within midwifery today, with up to 15% of babies requiring some form of resuscitation at birth. Recent research describes the benefits of using a multi-modal approach to teaching neonatal resuscitation, utilising both theory and simulated learning methods. One emerging method of simulation is that of virtual reality (VR), which has been recognised for its enormous educational potential in risk-free clinical skills training. Currently, however, there is limited research looking at the use of VR in emergency skills training. This article examines the literature to highlight the potential benefits that VR simulation could provide for emergency skills training, as well as the potential challenges that should be acknowledged.

Keywords: Virtual reality; midwifery; student; teaching; neonatal resuscitation

Midwifery education in Australia and the role of blended learning

Historically, nursing and midwifery education has been predominantly based around public hospital training in Australia. Training for nursing usually lasted three or more years, with midwifery undertaken once nursing training had been completed. During the mid-1980s, nursing and midwifery moved out hospital-based training and into tertiary education with practical clinical experience components (Australian Government Department of Health, 2013). In 2000, the first direct-entry Bachelor of Midwifery courses were established, allowing graduates to register and practise as midwives without first requiring a nursing qualification (Australian Government Department of Health, 2013).

With the shift from hospital-based training to tertiary education also came a shift in midwifery education. Traditionally, tertiary education was very didactic, delivering much of its content in the form of theory-based lectures, with structured clinical practicum hours undertaken in the clinical environment (Tierney et al., 2017). However, the move into the digital age has seen a shift into blended teaching methods which have become increasingly more popular since the mid-2000s (Güzer and Caner, 2014, Kliger and Pfeiffer, 2011). In today's current tertiary system, all midwifery programs in Australia utilise blended learning in some form (Cooper et al., 2012). Blended learning takes on a mixed structure, comprised of various methods of teaching such as self-directed learning modules, audio-visual elements, online learning, critical-thinking exercises, and face-to-face workshops and/or lectures (Kliger and Pfeiffer, 2011, Güzer and Caner, 2014).

Emergence of simulation in midwifery teaching

Within midwifery education, one of the most widely used teaching methods incorporated into blended learning environments is hands-on simulation. Simulation is an educational technique which aims to mimic elements of the real world to help achieve specific goals related to learning (Bogossian et al., 2012, Weller et al., 2012). Although simulation in healthcare education has been around in various forms for the last 40 years (Nehring and Lashley, 2009), it became a key educational strategy for the development of midwifery and nursing skills from the early 2000's (Cooper et al., 2012). Results of a national electronic survey in 2012 outlined simulation-based learning is extensively used in Australian midwifery curricula as part of a blended teaching model. The increased uptake of simulation in midwifery appears to be due to its benefits in allowing for development of many midwifery technical skills, as well as generic technical and non-technical skills (Bogossian et al., 2012).

Simulation teaching methods currently exist in many forms, including scenarios, peer-to-peer learning, partial task trainer models, standardised/simulated patients, low/medium and high-fidelity computerised task trainers and mannequins, screen-based computer simulations, virtual reality and haptic systems (Bogossian et al., 2012, Cooper et al., 2012, Weller et al., 2012, Nehring and Lashley, 2009). According to one systematic review conducted in 2012, there is evidence that simulated learning methods for midwifery skills is beneficial and has important educational and clinical advantages over more conventional approaches to teaching (Cooper et al., 2012). These benefits include increased confidence, competence and decision making abilities, as well as improvements in communication skills and clinical judgement. Simulated learning is also beneficial in ensuring midwifery students are safe in their clinical practice; improving safety outcomes for women and

babies in the clinical environment (Cooper et al., 2012, Bogossian et al., 2012, Weller et al., 2012).

Neonatal resuscitation

Simulation is particularly important when practising skills that may be infrequently encountered in practice, such as clinical emergencies (Cooper et al., 2012). Obstetric and fetal emergencies occur at low frequencies in the clinical setting, however they carry increased risk of morbidity and mortality to women and babies (Pliego et al., 2008). A wide range of obstetric emergency scenarios can be practised using simulation methods, making this method of teaching very adaptable. One of the most frequent emergencies encountered by midwives in clinical practice is neonatal resuscitation, with approximately 15% of newborn babies requiring some form of resuscitation at birth (Australian and New Zealand Council on Resuscitation (ANZCOR), 2017). Neonatal resuscitation is a critical skill that cannot be trained for enough, nor should it be learned procedurally on the job. Thus simulated learning is crucial for midwifery students to assist in enhancing their confidence prior to clinical placement where they may be confronted with this situation (Cooper et al., 2012).

Neonatal resuscitation training has shifted from instructor-driven didactic lectures and basic skills demonstrations, to utilising blended, interactive teaching through e-learning modules and hands-on simulation. Evidence suggests that multi-modal approaches to teaching neonatal resuscitation are the most beneficial for learning, particularly when training models incorporate simulation as a teaching method (Dempsey et al., 2015, Rakshasbhuvankar and Patole, 2014). Recent research has noted significant improvements in performance, stress hardiness, confidence, knowledge, communication, leadership and technical skills for

physicians, midwives and nurses undergoing hands-on simulation training when learning neonatal resuscitation (Pliego et al., 2008, Carolan-Olah et al., 2016, Bruno et al., 2016, Malmstrom et al., 2017)

The emergence of virtual reality in emergency simulation training

One emerging form of simulation is that of virtual reality (VR). Whilst, VR has notably been around for decades, equipment was initially expensive and cumbersome to use. Within the last decade, VR technologies have become more advanced, affordable and accessible (Ferguson et al., 2015). VR simulation can be defined as one which is computer-based, interactive and three-dimensional. It is experienced through either sensory perception, physical movement and/or text or speech communication (Ludlow, 2015). VR appears to be a much misused term within the literature, often describing technologies that lack these essential elements. Caution is therefore required when examining literature to ensure the intervention introduced is indeed within the realm of VR. VR-based applications can also have varying levels of immersion, ranging from virtual worlds or patient representations on a computer, to full-scale simulators, to fully immersive head-mounted devices (HMD) with position tracking technology (Ludlow, 2015, Hoffman and Vu, 1997, Ferguson et al., 2015).

VR simulation can be viewed as the reinvention of hands-on simulation. Even 20 years ago, VR was recognised for its enormous educational potential, with Hoffman and Vu (1997) seeing prospective benefits in risk-free clinical-skills training. There is a paucity of research examining the use of VR simulation when providing emergency skills training, including disaster training, mass casualty triage, intubation and decontamination training (Farra et al., 2015a, Vincent et al., 2008, Farra et al.,

2015b, Binstadt et al., 2008). Due to the limited body of evidence, results regarding the benefits of VR simulation in emergency skills training are still debated, with some studies showing improvements in performance and knowledge (Binstadt et al., 2008, Vincent et al., 2008) while others show no significant change in outcomes (Farra et al., 2015b). Further research is therefore required to discover the most promising areas where VR simulation can benefit emergency skills training.

No current research exists examining the use of VR simulation when learning neonatal resuscitation, thus highlighting a gap in the literature. This is important as neonatal resuscitation is a skill that extends outside of midwifery and into nursing and medical fields. It is performed by health professionals such as neonatologists, paediatric nurses, child and family health nurses and paramedics (Malmstrom et al., 2017). Therefore, many healthcare professionals require knowledge and competence in safely performing this skill. In Australia, neonatal resuscitation is a skill mandated in most states for midwives to undergo annual competency assessment (NSW Health, 2008, Latimer and Evans, 2015, Government of Western Australia, 2017). Given this requirement, VR simulation may provide an appropriate teaching method when there is limited access to mannequin-based training or facilitator-led workshops (Chang and Weiner, 2016).

Potential benefits of VR simulation

According to Chang and Weiner (2016), VR simulation may afford benefits for emergency training due to the on-demand, user-driven method of learning, rather than relying on the preparation, personnel and scheduling necessary for hands-on simulation sessions. VR allows for increased flexibility and asynchronous learning opportunities (Ludlow, 2015, Chang and Weiner, 2016). Depending on the VR

platform being used, learners can practise the simulation in their own time away from the clinical or university environment. This has significant potential in reducing time commitments for facilitators, reducing costs for universities/organisations, and reducing the number of resources required for simulation training (Ferguson et al., 2015, Chang and Weiner, 2016).

Another advantage for VR is that of replicability of the simulation, enabling control over any potential variation and allowing standardisation of learning and practise. Hands-on simulation sessions are run by a facilitator, which may unintentionally lead to slight variations in training and practise from session to session for students (Chang and Weiner, 2016). This variation may mean differences in the way learners benefit from the simulation. VR removes this variable by having repeatable scenarios, which is particularly important in formal assessment training (Chang and Weiner, 2016). With an infinite potential to replicate, VR simulation can also easily be distributed across a large range of devices, making it accessible to both individuals and groups all over the world. The improved portability, availability and affordability of VR is seeing distribution of this technology increase and become more popular (Chang and Weiner, 2016, Ludlow, 2015).

Data collection for simulation-based research can also be enhanced when using VR simulation (Ludlow, 2015, Chang and Weiner, 2016). Most VR systems have embedded software which may also contain specialised features such as accelerometers, video cameras or other technology capable of collecting data. HMD equipment can track the gaze and eye movements of the student, providing insight into where the student places most of their focus within the simulation (Chang and Weiner, 2016). Various analytics data can also be collected, such as the amount of time a student spent undertaking the simulation, how far they progressed in the

scenario, and how frequently it was accessed (Chang and Weiner, 2016). Wearable physiology sensors, such as Equivital, can be added to collect data on the student's heart rate, respiration rate and skin conductivity, providing insight into the level of stress experienced by the learner (Chang and Weiner, 2016, Equivital, 2017).

Potential challenges of VR simulation

As with all new teaching methods, there are potential challenges with VR that should be acknowledged. Unless a fully-immersive HMD VR simulation is used, learners are generally interacting with a computer device with 2-dimensional screen. This can impact on the fidelity experience for the learner when compared to hands-on simulation (Chang and Weiner, 2016, Ludlow, 2015). As a result, students need to be kept engaged with VR simulation. Very linear, structured scenarios could becoming boring and predictable and lead to a lack of interest if new, more complex scenarios are not available (Ferguson et al., 2015, Ludlow, 2015). This could be especially true for emergency scenarios as these are often unpredictable in the clinical setting (Chang and Weiner, 2016). A variety of VR scenarios would therefore be beneficial for training, however this in itself presents challenges due to the current constraints of artificial intelligence technology, limitations in the equipment presently available, and screen resolution which may limit realism (Ludlow, 2015).

There can be high outlay costs when considering VR simulation. This includes the development time, piloting the simulation and having it distributed across multiple platforms for use. Greater time and investment will be needed depending on the level of detail and realism within the simulation (Chang and Weiner, 2016, Ludlow, 2015). Educators and researchers require training on the use of the equipment so they can successfully implement this technology into teaching

and educational curricula. It is also recognised that technology can be prone to glitches or faults and regular maintenance and updates are required to keep the equipment functioning optimally (Chang and Weiner, 2016). Old, outdated equipment will likely need upgrading and replacing more frequently than hands-on simulation mannequins and equipment (Chang and Weiner, 2016).

Additionally, there are issues of motion sickness and dizziness reported by VR users in 22-56% of cases when using immersive HMD equipment (Treleaven et al., 2015, Munafo et al., 2017), with women being more susceptible to the effects than men (Munafo et al., 2017). Oculus, maker of the Rift and Samsung Gear VR HMD, recommends taking a break from simulation every 30 minutes to minimise the effects of prolonged dizziness (Oculus, 2015). Individuals who need to remove glasses to participate in a HMD VR simulation could also experience worsened dizziness and may be unable to fully participate due to underlying vision problems (Oculus, 2015).

Conclusion

The shift towards blended learning has seen the introduction of multiple teaching methods into midwifery curricula, including online, digital learning and hands-on simulation. VR simulation combines digital learning and simulation together, creating a unique, three-dimensional, interactive experience that can provide flexible and asynchronous learning. VR can provide a safe environment to practise a wide variety of clinical skills, including emergency scenarios such as neonatal resuscitation where it can be difficult to gain appropriate experience in real-time situations. Potential challenges exist in the form of impacted fidelity when using

screen-based technologies, financial considerations and user motion sickness. There may be challenges in the form of disinterest or lack of engagement by users over time. And there is also the realistic likelihood of experiencing technical issues and the need for ongoing maintenance and updating of the technology.

With the fast-growing popularity of VR today, it seems an inevitability that VR simulation will become more prominent in health education, training and research. Research on the use of VR simulation in emergency skills training, however, is currently limited, with no literature available examining the use of VR simulation in neonatal resuscitation training. Neonatal resuscitation is the most frequently encountered neonatal emergency within midwifery, and also forms a crucial skill required by some nurses, physicians and paramedics. With mandatory, annual competency assessment in neonatal resuscitation required in Australia, VR simulation would allow midwifery students to repeatedly practise this skill in a risk-free environment, potentially leading to improvements in knowledge, confidence and performance. Future research in this area may demonstrate VR simulation as a suitable alternative or adjunct to teaching obstetric and neonatal emergencies such as neonatal resuscitation.

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Considerations of using virtual reality for teaching neonatal resuscitation to midwifery students

Highlights:

- Use of virtual reality is emerging within tertiary healthcare education and training
- Virtual reality can further enhance the simulation experience for midwifery students
- Neonatal resuscitation would be an ideal skill to teach using virtual reality
- Consideration for potential benefits and challenges is required