The role of virtual patients in medical education: a review of the literature

KEY WORDS
- E-learning
- Case-based learning
- Computer assisted case-based learning
- Interactive patient scenarios
- Medical education
- Virtual patient

Background: Virtual Patients (VPs) are an interactive computer-based clinical patient scenario used in medical education. To determine how VPs are used in medical education, a literature search and review was completed. **Methods:** A literature search was completed using Google Scholar. Keywords used were "Virtual Patient", "Case-based learning" and "Medical Education". **Conclusion:** VPs are a teaching tool used throughout medical education, using clinical cases to bridge the gap between knowledge and clinical practice. The impact of VPs has been equally as effective for medical students as traditional non-computer based methods. However, the role of VPs in specialities such as wound care is less clear and requires more evidence. This is part one of two articles. In part two, the author describes the development and application of a wound healing VP integrated into the medical curriculum at Cardiff University Medical School.

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Virtual Patients (VP) have been widely adopted within the training and development of healthcare professionals (Cenden et al, 2012). Adopting a case-based learning methodology allows the reader to follow a patient journey, whilst critically analysing the patient's case (Cook et al, 2009). There are areas of medical school curricula that may benefit from the development of VPs. In particular, areas of clinical practice that medical students may not have much clinical exposure too (Patel et al, 2008). For example, wound healing (WH) is an area of health care that is under appreciated in medical school curricula (Patel et al, 2008). Despite there being an estimated 2.2 million wounds managed by the NHS in 2012/2013 (Guest et al, 2015). Therefore, the development of VPs focusing on WH and the management of chronic wounds may greatly improve medical student education in this area.

CASE-BASED LEARNING (CBL)

CBL was defined by Thistlethwaite et al (2012):

"The goal of CBL is to prepare students for clinical practice, using authentic clinical cases. It links theory to practice, through the application of knowledge to the cases, using inquiry-based learning methods."

However, there appears to be no consensus on the definition within the literature.

CBL has been shown to be effective at engaging students in active and collaborative learning within medical education (Hakkarainen et al, 2007). Therefore, exploring its benefits and limitations will be useful in the development of case specific resources such as VPs.

ROLE OF E-LEARNING IN MEDICAL EDUCATION

Multimedia e-learning has been noted to enhance teaching and learning methods by increasing accessibility, standardisation and ease of editing for up to date information (Ruiz et al, 2006). The interactive nature of the e-learning model engages the participant, shifting them to an active learning experience. This removes the passivity of a teaching centred approach (Ruiz et al, 2006).

VIRTUAL PATIENT

The term 'virtual patient' is used to describe a type of computer-based program that simulates real-life clinical scenarios (Ericsson KA, 2004; Cook et al, 2010a). VPs assist learners to take on the role of a healthcare provider in order to obtain

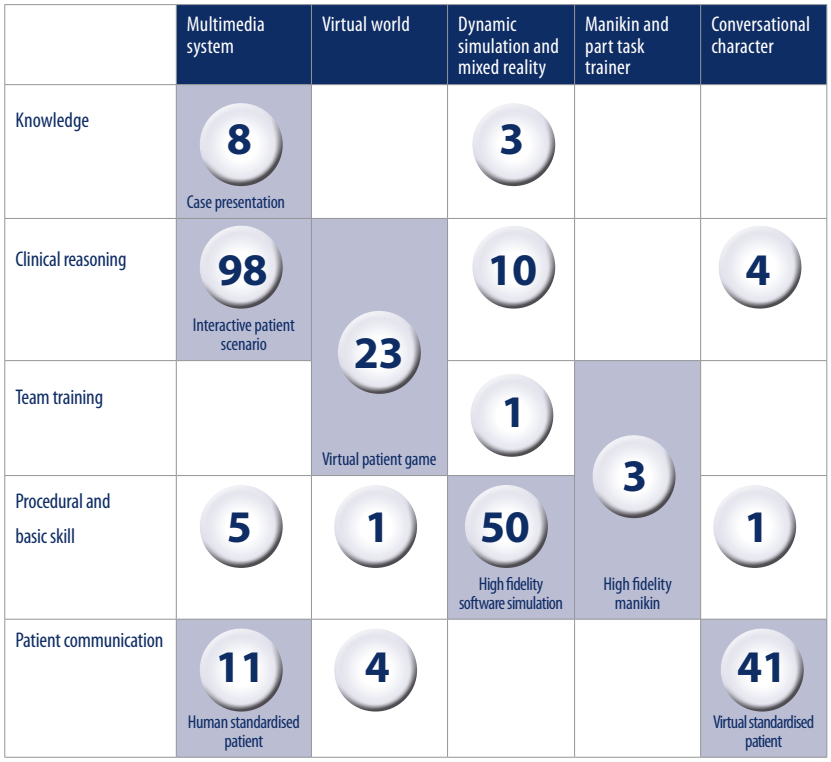

Figure 1. Overview of VP classes with assigned number of articles (*n*=234) based on competency and technology (adapted from Kononowicz et al, 2015)

Table 1. Search terms

1		2	3
Virtual Patients OR VP-based learning	AND	Case based learning OR Case-based learning OR Patient centred learning	Medical education OR Medical student OR Healthcare education

Table 2. Search methods

1	2
Database	Using search terms from *Table 1* in Google Scholar database.
Reference list	Check reference list of included papers for additional articles.
Citation search	Check if included papers had been cited in more recently published papers.

histories, conduct physical examinations, and propose diagnoses and therapeutic interventions (Association of American Medical Colleges, 2007). The primary form of VPs used in healthcare literature was found to be Interactive Patient Scenarios (Kononowicz et al, 2015). However, it is a broad term that encompasses simple interactive patient cases to complex software simulations. Although the premise for VPs is well documented, there is no agreement over the complexity and technology required of VPs. Kononowicz et al (2015) conducted a literature review to classify the use of the term 'virtual patient' in healthcare education. *Figure 1* illustrates the classification framework they produced based on the competency and technology utilised within the literature (Kononowicz et al, 2015). This makes the use of VPs more explicit, however, it demonstrates the variation in sophistication.

AIMS AND OBJECTIVES

The purpose of this report is to evaluate the available literature about VPs as an example of CBL, to understand its significance within medical education. The objectives were to:

- Illustrate the role of VPs in medical education
- Analyse the benefits and limitations of VPs in medical education
- Compare online virtual patients to live VPs
- Application of VPs in the delivery of wound healing in medical education.

METHODS

A literature review was undertaken to establish whether VPs are a useful tool within medical education. The topic reviewed was chosen to aid in the development of a VP, exploring chronic leg wounds in the context of wound healing for medical students following a CBL based curriculum. For this reason, it was important to gain an evidence base for the usefulness of VPs as an example of CBL.

The literature search was undertaken using Google scholar database. A single database was used for ease of retrieving citations in the confines of a Student Selected Component (SSC) module. However, the database was linked to Cardiff Universities library database to improve the breadth of literature available. The number of articles

retrieved from Google Scholar were sufficient and fulfilled all aspects of the search criteria. Ideally, a greater number of databases would have been used to reduce bias and expand the literature sources available for review.

A keyword search strategy (*Table 1*) was utilised to limit searches to literature within the field and topic area. The strategy employed the use of Boolean Operators to maximise the breadth of evidence identified (*Table 2*). Additional articles were identified from 'related articles' from the reference lists of included articles and the Google Scholar search (*Table 2*).

The following criteria were used to exclude studies from this literature review:

- Articles in a language other than English.
- Key search criteria not mentioned within the articles (only in abstract or title).
- Articles centred around problem-based learning.

RESULTS

1,040 articles were identified using the search strategy (*Table 1*). Twenty-five articles were included in the literature review. The papers used were dated from 2000 to 2017, in order to include the most up-to-date articles. As well as to restrict the number of papers retrieved for closer review. *Figure 2* shows the stages of the literature review.

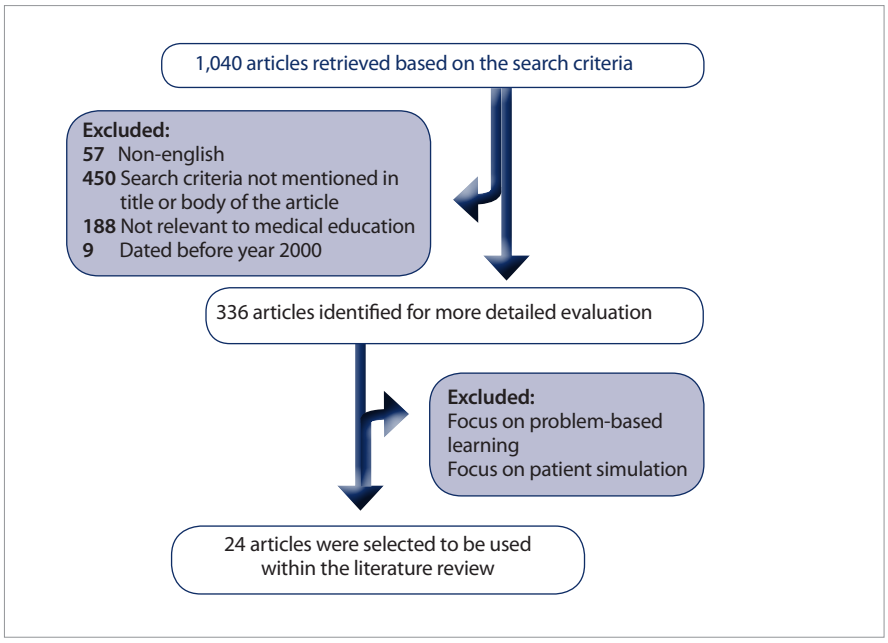

Figure 2. Flow diagram demonstrating the protocol for article selection

DISCUSSION

The review identified that there is a limited amount of experimental literature on the utility of VPs within medical education. However, the findings detailing their implementation and use are encouraging. A number of studies have demonstrated that VPs facilitate learning and improve learning outcomes when compared to no intervention (Cook et al, 2010b). When compared to other methods of simulation, VPs were equally efficacious with respect to learner satisfaction and learning outcomes (Cook et al, 2010a; Consorti et al, 2012; Triola et al, 2006).

The role of virtual patients in medical education

Research in multimedia learning has shown novice learners perform better when using structured worked examples compared to advanced learners who require practice problems (Cook et al, 2009). Therefore, when developing VPs for medical students, the consideration must be made as to the recipient's level of knowledge. Cook et al. suggest the role of VPs aligns with the development of critical reasoning rather than providing core knowledge (Cook et al, 2009). Critical reasoning is defined by three components:

- Process — conceptualisation, application and evaluation of information.
- Method — observation, reflection and communication based on experiences.
- Purpose — knowledge acquisition and utilisation (Harasym et al, 2008).

The objective of acquiring a critical thought process is the ability to analyse and evaluate situations with a view to improving it (Harasym et al, 2008). Norman concluded critical reasoning is the result of pattern-recognition techniques and conceptual knowledge (Norman, 2005). These abilities are central components to becoming a competent physician (Cook et al, 2010b). The nature of VPs makes them ideally suited to this task. However, there are no guidelines for the structure and development of VPs within the literature. Thus, interpretation of their design and use for implementation is still unclear. This is apparent, by the lack of consensus over what comprises a VP, in its level of sophistication and use of technologies.

According to Berman et al, the evidence suggests

Key points

- VPs aid in the development of pattern-recognition and critical reasoning
- There is a lack of guidance in the development of VPs as there is a lack of consensus over its definition
- VPs are equally as effective as traditional methods of medical education
- VPs provide an accessible resource for repetitive clinical practice without any risk to patients
- Medical students report a high amount of satisfaction when using VPs
- Participants reported feeling more comfortable using VPs than live standardised patients
- The role of VPs in wound healing is unclear, due to the lack of literature available on the topic.

that integrating computer-assisted case-based learning (CA CBL) methods with traditional methods of medical education is superior to either alone (Berman et al, 2009). With respect to student use and satisfaction, the implementation of CA CBL as an 'add-on' to the curriculum received mostly positive feedback (Haag et al, 2007; Jäger et al, 2014). However, students did not want to see instructor-led training replaced but complemented with new methods of learning. Kerfoot et al (2007) conducted a randomised controlled trial, evaluating the effectiveness of web-based training in delivering curriculum content to medical students over a 9-week period. Outcomes were measured and compared to standard curriculum outcomes using an online test administered prior, between and post completion of all 3 modules. Student test scores significantly improved when undertaking web-based training compared to standard curriculum alone (Kerfoot et al, 2007). Despite this study demonstrating a high level of evidence of a significant difference in test performance, subsequent studies have been unable to reproduce this result.

The benefits and limitations of virtual patients in medical education

VPs provide an accessible learning tool with opportunities for repetitive practice without patient risk (Iseenberg, 2006). The ability to integrate and edit evolving medical evidence into VPs with ease ensures the most up to date sources of information and an advantage over non-electronic resources. Computers with Internet access are widely accessible to the student population, enabling engagement with web-based medical resources within the clinical environment. Additionally, these resources can be used outside of clinical teaching providing students with effective & enjoyable resources to use in their own time.

A meta-analysis study examining the efficacy of VPs in medical education found only one out of the 12 studies analysed, measured the time spent on learning activities (Consorti et al, 2012). Therefore, the amount of exposure to VP is an issue to be considered when analysing the literature. Cook et al compared learning time and efficiency of Internet-based versus non-computer instruction. They concluded both methods take the same amount of time, with knowledge positively correlating with time (Cook et al, 2010b). An explanation for the positive effect of VPs may be a longer period spent using VPs by learners compared to other learning methods. For example, Gesundheit et al (2009) found medical students were highly satisfied with the use of VPs, which could be a variable in their engagement in prolonged learning activity.

Comparison of online virtual patients to live standardised patients

When compared to live standardised patients (SP), the VP has been rated equally as effective by a range of healthcare professionals. Experimental results show the diagnostic skill and ability of groups using VPs versus SPs was equivalent (Triola et al, 2006). Despite VP being a less realistic representation of a patient compared to SPs, participants appreciation of their value was not negatively impacted. Additionally, participants felt more prepared to treat the VP, perhaps due to the learning environment (Fleetwood et al, 2000). Simulations are undertaken in an environment where actions have or appear to hold greater consequences compared to that of a virtual space.

Application of virtual patients in the delivery of wound healing in medical education

There are few existing examples of the use of VPs in the literature on the delivery of wound care management in medical education. However, one study by Jorge et al (2016) did identify first-year nursing students using virtual reality (VR) technology and VPs performed significantly better (p <0.001) in identifying wound types and evidence of wound healing than those of them using VPs alone. This suggests that direct exposure to wounds and their clinical management cannot be replaced by VPs. However, this study did not examine the success of VPs compared to a control. Therefore, a conclusion cannot be drawn as to the worth of VPs in the delivery of wound healing teaching. VR technology is expensive and not readily accessible. Therefore, increasing the interactivity of VPs may increase efficacy and decrease costs in situations where VR is not available and students lack sufficient exposure to wound management on placement.

There is ambiguity across the board with respect

to definitions and understanding of what case-based learning and VPs comprise. This makes it difficult to assess the quality of VPs from the literature, as the title 'virtual patient' encompasses vastly different levels of sophistication and technology. This provides an opportunity to explore the terminology used and distinguish technology types utilised in the provision of VPs. Therefore, there is a prospect of a clearer evidence-base established for each technology type to be used in medical education.

CONCLUSION

Specialities, like wound care, could benefit with the addition of VPs, as they can provide evidence-based patient cases that allow safe practice for students who may not get the exposure on placement. However, research is needed to explore the role of VPs in the delivery of wound care teaching and how this may be integrated within medical curricula. WUK

NEXT ISSUE: PART TWO

In part two, the author describes the development and application of a wound healing VP to be integrated into the medical curriculum at Cardiff University Medical School.

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