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High-fidelity medical simulations and most effective learning

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Review citation

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What are the features and uses of high-fidelity medical simulations that lead to most effective learning? BEME Guide No 4. Medical Teacher 27, 1, pp 10-28.

Review website

http://bemecollaboration.org/Published+Reviews/BEME+Guide+No+4/

Keywords

Medical simulation, high-fidelity, learning

Headline conclusions

- While research in the field of high-fidelity medical simulations needs improvement in terms of rigor and quality, the evidence suggest that high-fidelity medical simulations are educationally effective; and simulation-based education complements medical education in patient care settings.
- There is documented value in respect of the provision of feedback, repetitive practice, integration of simulators into the curriculum, graded levels of difficulty, the use of simulation as one of multiple learning strategies, the provision of clinical variation, a controlled environment, individualisation of learning, definition of learning outcomes and ensuring validity as a learning tool.

Background and context

Simulations are now in widespread use in medical education and medical personnel evaluation. Outcomes research on the use and effectiveness of simulation technology in medical education is scattered, inconsistent, and varies widely in methodological rigor and substantive focus.

Review objectives

The goal of the high-fidelity simulation review was to determine from the existing literature the best evidence for using high-fidelity simulation in medical education and to identify the features and uses of high-fidelity medical simulations that lead to most effective learning.

Review methodology

Five literature databases (ERIC, MEDLINE, PsychINFO, Web of Science, and Timelit) were searched, employing 91 single search terms and concepts and their Boolean combinations. Hand searching, Internet searches, and attention to the "grey literature" were also used. The aim was to perform the most thorough literature search possible of peer reviewed publications and reports in the unpublished literature that have been judged for academic quality.

Four screening criteria were used to reduce the initial pool of 670 journal articles to a focused set of 109 studies: (a) elimination of review articles in favour of empirical studies; (b) use of a simulator as an educational assessment or intervention with learner outcomes measured quantitatively; (c) comparative research, either experimental or quasi-experimental; and (d) research that involves simulation solely as an educational intervention.

Data were extracted systematically from the 109 eligible journal articles by nine independent coders, using a standardized data extraction protocol. Qualitative data synthesis and tabular presentation of research methods and outcomes were used. Heterogeneity of research designs, educational interventions, outcome measures, and timeframe precluded data synthesis using meta-analysis.

Implications for practice

- **Provide feedback during the learning experience with the simulator.** Fifty-one (47%) of journals report that educational feedback is the most important feature of simulation-based medical education.
- **Learners should repetitively practice skills on the simulator.** Forty-three (39%) of journals identified repetitive practice as a key feature involving the use of high fidelity simulations in medical education.
- **Integrate simulators into the overall curriculum.** Twenty-seven (25%) of journals cite integration of simulation-based exercises into the standard medical school or postgraduate educational curriculum as an essential feature of their effective use.
- **Learners should practice with increasing levels of difficulty (if available).** Fifteen (14%) of journal address the importance of the range of task difficulty level as an important variable in simulation-based medical education.
- **Adapt the simulator to complement multiple learning strategies.** Eleven (10%) of journal identified the adaptability of high-fidelity simulations to multiple learning strategies as an important factor in their educational effectiveness
- **Ensure the simulator provides for clinical variation (if available).** Eleven (10%) of journals cited simulators that capture a wide variety of clinical conditions as more useful that those with a narrow range.
- **Learning on the simulator should occur in a controlled environment.** Ten (9%) of journals emphasized the importance of using high-fidelity simulations in a controlled environment where learners can make, detect and correct errors without adverse consequences.
- **Provide individualized (in addition to team) learning on the simulator.** Ten (9%) of journals highlighted the importance of learners having reproducible, standardized, educational experiences where they are active participants, not passive bystanders.
- **Clearly define outcomes and benchmark for the learners to achieve using the simulator.** Seven (6%) of journals cited the importance of having clearly stated goals with tangible, outcome measures that will lead to learners more likely mastering skills.
- **Ensure the simulator is a valid learning tool.** Four (3%) of journals provided evidence for the direct correlation of simulation validity with effective learning.

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