Update in
Anaesthesia

Low cost simulation training in anaesthesia

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Summary

Simulation is increasingly used in medical education, particularly in anaesthesia and critical care. In the UK many centres focus on use of high fidelity mannequins, however evidence suggests that many of the benefits of teaching through simulation can be gained using basic, low technology equipment. This is particularly true of novice learners. Simulation techniques should be chosen carefully as most modalities are well-suited to particular aspects of learning.

QUESTIONS

Consider the following questions. The answers are contained within the text.

1. What is the definition of fidelity?
2. List the different forms of simulation available.
3. Answer True or False for the following statements:
   a. The use of high tech computer-controlled manikins has been proven to be the most effective way of providing simulation teaching.
   b. Cognitive overload results in a decline in learning.
   c. An instructor providing video assisted feedback is the most effective way of providing feedback.

INTRODUCTION

Simulation is defined as a set of techniques to replace or amplify real experiences with planned experiences. The experiences are often immersive in nature and should evoke or replicate substantial aspects of the real world in a fully interactive fashion. (*Immersive* means having the perception you are physically present in a situation that is not real, and also used in relation to 'virtual reality' technologies). Simulation training in medicine has been shown to be effective and to improve performance; it is associated with moderate to large improvements in educational outcomes when compared to no intervention, and small to moderate improvements when compared to instructional approaches, such as lectures. This potential has been widely accepted by the anaesthetic community, although we have not yet fully established how and when the use of simulation is most effective.

Medical simulation training in the UK is generally associated with use of high-tech, computer-controlled manikins that are used in scenario based training. This type of simulation is traditionally known as *high fidelity*. However simulation may take many diverse forms and some of the most useful and productive training can be achieved without the need for expensive equipment.

SIMULATION IN ALL ITS FORMS

Simulation takes many forms from home made part-task trainers, to high-tech computer-controlled manikins in simulation suites.

There are several proposed classification systems for simulators used in anaesthesia, though none are widely accepted (Table 1).

Table 1. *Classification of simulators*

Type of interaction

- Hardware based – using physical interaction
- Screen based – using a mouse and keyboard
- Virtual reality based – using headsets or haptic devices that provide physical feedback
- Human based – using actors

Response of the simulator

- No physiology – no physiological response
- Physiology – the simulator responses are either controlled by a script or use a mathematical model to determine response

Type of teaching

- Knowledge
- Psychomotor skills
- Drills
- Performance

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THE SCOPE OF SIMULATION USED IN ANAESTHESIA

Hardware based simulators

- *Part task trainers* (commercial) e.g. epidural models, peripheral nerve block models, model heads for airway skill and IV access models.
- *Part task trainers* (home made) e.g. Fruit models for epidural training, ultrasound phantoms made from gelatin or meat, cricothyroidotomy models from tape and tubing and animal specimens.

Screen based simulators

- *Computer based simulators*. There are many of these available.

Virtual reality based simulators

- These exist for IV access training and are in development for ultrasound guided regional anaesthesia.

Human based

- *Role-play scenarios*, which may be performed using members of staff as actors, or by using standardised patients for greater psychological fidelity. Standardised patients are actors who may have the physical characteristics of the patient they are portraying, e.g. amputees with theatrical make-up for trauma scenarios.

Other types of simulator

- *Hardware and human based*. High-tech, computer-controlled simulators, which are traditionally known as high fidelity.
- *Hybrid simulators* which are devised using part task trainers and actors.

WHAT IS FIDELITY?

Fidelity is defined as the degree of exactness with which something is copied or reproduced. Simulation training has traditionally been described as high or low fidelity, with high fidelity meaning immersive computer-controlled manikin based simulation, and low fidelity describing other types of simulation training. There are different forms of fidelity, and the use of high and low fidelity may be misleading. The nomenclature has changed to reflect this:

- Physical fidelity (it looks real)
- Functional fidelity (it works)
- Psychological fidelity (is has the same effect on the user as the real thing).

For example, using a banana to teach the loss of resistance technique for epidural placement is low cost and low tech, but has a high degree of functional fidelity.

It is not necessary for all aspects of fidelity to be high in order to provide effective simulation training. However it is essential to provide fidelity appropriate to the desired learning objectives.

OPTIONS WHERE RESOURCES ARE LIMITED

There is evidence that the use of high tech simulators does not always add educational benefit and that less expensive technologies (animal models, simple manikins, wooden box trainers) can be used without sacrificing effectiveness.

When learners compared a commercially available part task trainer for cricothyroidotomy with a home made model, similar evaluation scores were found in both groups. The use a banana for epidural insertion training has been shown to provide an effective model for demonstrating loss of resistance to novice trainees. Comparison of fibreoptic intubation training on low or high fidelity models, found no correlation between the training method used and time to visualization of the carina. Regional anaesthesia teaching models can be constructed using Gelatin, processed meat, or animal models, and communication skills may be taught effectively without any expensive equipment.

A recent review found that anatomically correct simulators do not always add value to education, and that trainees are satisfied and learn well from simulators consisting of realistic tissues (animal and fruit models).[2]

When comparing learning outcomes of simulation with high or low fidelity, a further review found that, in nearly all of the studies, there was no significant advantage of high fidelity simulation over low fidelity simulation.

EFFICIENCY AND EFFCTIVENESS OF SIMULATION TRAINING

In order to delivery efficient simulation training, both in terms of time and money, the chosen simulation modality should be suited to the learning outcomes required.

Using immersive computer controlled manikin based simulation to teach the management of a 'can't intubate, can't ventilate' (CICV) event, in learners without the necessary knowledge, skills and drills, is likely to be inefficient and less effective. Immersive simulation is expensive both in terms of time and money, and should be used when the maximal benefit can be gained.

Training to perform a complex procedure, such as CICV, can be broken down into sequential steps:

- **Knowledge** – the information required to perform the procedure (tracheal anatomy)
- **Skills** – technical skills (how to perform crico-thyroid puncture)
- **Drills** – practical ability to perform a drill (the steps in the CICV algorithm)
- **Performance** – The ability to integrate all of the above in to practice, both real and simulated (integrating CICV into a scenario with distractions).[11]

These different components are taught most effectively by different modes of teaching, some simulated, some not (Table 2)

We know from studies in psychology that working memory has limited capacity, and learning is impaired when this capacity is overloaded. Simulation training in learners with limited clinical experience is associated with a high cognitive load, and they are therefore at risk of cognitive overload, and a resultant decline in learning. When an individual is in the early stages of learning, information should be presented in smaller units to allow efficient processing and assimilation.

Table 2. *Components of a procedure and how they may be taught*

Domain	Modality taught by:
Knowledge	Lectures Tutorials Demonstrations e-learning
Skills	Home made or commercial part task trainers
Drills	Part task trainers, or full manikins, and may involve some role play. Training in skills and drills allows opportunity for repetitive blocked practice with frequent feedback. This is the most efficient method of learning for novice learners.
Performance	Immersive computer controlled manikin based simulation, when the necessary knowledge, skills and drills are in place. Immersive simulation allows random practice, increased stress and delayed feedback with opportunity for self reflection. This method is most efficient for proficient learners.

This idea is supported by a learning model known as the challenge point framework. As task difficulty increases, learning also increases. This continues until the optimal challenge point is reached. At this point practice performance begins to decrease, immediate performance is negatively affected, but long term learning is enhanced. If the difficulty of the task is increased beyond the optimal challenge point, then both practice performance and learning are impaired. Therefore the aim is to target the learning to the challenge point for each individual learner, on the continuum from novice to expert.

DE-BRIEFING AND FEEDBACK

Debriefing and feedback are about the realisation of a performance gap, and have been shown to increase the efficacy of simulation training. However, in a recent systematic review, the combination of two or more information sources during feedback does not add benefit, compared with a single information source. An instructor providing video assisted feedback was no better than an instructor providing verbal feedback alone. This may be due to the stress of public evaluation limiting the effectiveness of the feedback, and should encourage those running simulator sessions without the capacity to provide visual feedback.[2]

CONCLUSION

Simulation training has been shown to be beneficial in medical education, and encompasses a wide range of teaching methods, of which the cheaper, simpler options may be more efficacious, especially for novices.

By matching the simulation modality used to the learning outcomes required, simulation training can be included in a training program with maximal cost and time efficiency. In situations where financial constraints limit the availability of equipment, high tech simulation may be reserved for advanced training and can reasonably constitute only a small part of a simulation education programme.

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