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First of all: Do not harm! Use of simulation for the training of regional anaesthesia techniques: Which skills can be trained without the patient as substitute for a mannequin

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Character of clinical skills training is always influenced by technical improvement and cultural changes. Over the last years, two trends have changed the way of traditional apprenticeship-style training in regional anaesthesia: firstly, the development in ultrasound-guided regional anaesthesia, and secondly, the reduced acceptance of using patients as mannequins for invasive techniques. Against this background, simulation techniques are explored, ranging from simple low-fidelity part-task training models to train skills in needle application, to highly sophisticated virtual reality models – the full range is covered. This review tries to discuss all available options with benefits and neglects. The task in clinical practice will be in choosing the right level of sophistication for the desired approach and trainee level. However, the transfer of simulated skills to clinical practice has not been evaluated. It has to be proven whether simulation-trained skills could, as a last consequence, reduce the risk to patients.

Introduction

Cultural changes in medicine have reduced the acceptance of the traditional apprenticeship-style training in patients and trainees. This influences the character of clinical skills training. Simulation is

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an educational technique that allows interactive, and at times immersive, activity by recreating all or part of a clinical experience without exposing patients to the associated risks. For this reason, the number and range of technologies used in simulation for education of health-care professionals are growing exponentially. These range from simple low-fidelity part-task training models to highly sophisticated computer-driven models [1].

This paper reviews the range of currently available simulators and the educational processes that underpin simulation training in regional anaesthesia. The safe performance of regional anaesthesia requires knowledge of theoretical facts, such as anatomy and physics, and good manual skills. Ethically, skills in needle placement should be gained in a phantom before performance of nerve blocks on patients in clinical practice. Trainees should be able to learn and practise different techniques in a safe environment. Simulation in this complex setting should create a realistic environment with standardized and reproducible scenarios without endangering patients [2].

This review focusses on peripheral nerve blocks. In this field, most simulation techniques can be elucidated. These are easy to transfer to neuraxial blockades such as epidural and spinal anaesthesia. However, different techniques such as regional anaesthesia performed with nerve stimulation of peripheral nerves or ultrasound-guided regional anaesthesia require different simulation scenarios.

Nerve stimulation guided peripheral nerve blockade

Regional anaesthesia with nerve stimulation technique encompasses several skills, such as positioning the patient, determination of the needle insertion site with the help of surface and anatomic landmarks and the use of electric nerve stimulator in order to locate nerve cords with muscular response (e.g., twitches in the hand or knee). After successful localization, local anaesthetics are injected to block the desired nerve.

One essential requirement for simulation is a precise, anatomic plausible model of the nerve cords. In addition, representations of bones, blood vessels, muscles and skin tissue are needed to frame the peripheral nerve system.

The simulation itself should allow training of all steps of a typical procedure as described above. Especially, anatomical correct models with options for positioning extremities and reality-based haptic impressions are required. Perception and manipulation of these objects using sense of touch and proprioception should create the illusion of body substance and needle force within the virtual world. Even though specialized haptic solutions are used by applications for simulation of insertion of IV lines and central venous catheters, there is currently no phantom for nerve stimulation-guided regional anaesthesia of peripheral nerves available.

On the other hand, high-end solutions such as virtual-reality (VR)-based simulators are developed in feasibility studies [4].

Virtual reality

VR is a computer-based technology that presents virtual objects or environments to all human senses in a way that is identical to their natural counterpart. Improvements in computing technology and in the development of techniques for acquiring data (e.g., medical imaging) are able to generate models. These are often combined with part-task trainers to allow a physical interaction to take place within the virtual environment where haptic feedback is used to produce a feeling of resistance when using instruments within the simulated environment [5].

To give an impression, Fig. 1 shows a VR-based simulator for regional anaesthesia with two haptic interaction devices for palpation and needle insertion. Magnetic resonance imaging (MRI) morphology and magnetic resonance angiography (MRA) were acquired from five subjects for the inguinal region. From these sources, three-dimensional anatomical data sets were created and nerves modelled. This model of flexible anatomical structures was implemented in the VR toolkit VISTA using modules for collision detection, virtual humanoids, interaction and visualization [6].

Clinical acceptance of this specialized haptic solutions is very low. The reasons are firstly due to the complexity of this elaborate setting. Data calculation from medical imaging and preparation of the high-fidelity setting need time, education and manpower. This may be available in feasibility studies