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Education in Regional Anesthesia: The Next Level

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Abstract The apprenticeship model of teaching procedural skills in regional anesthesia may no longer be effective because of the increasing number of peripheral nerve blocks currently performed. A time-based training program is restrictive, and this is compounded by limitations in duty hours and time pressures concerning operating room efficiency. Forty percent of residents do not fulfill the recommended minimum number of blocks required upon graduation. In this review we discuss the issues with the current apprenticeship model of teaching; how simulation addresses some of these issues, and why the future of regional anesthesia education will be modeled on an experiential competency-based paradigm as opposed to the traditional time-based model.

Keywords Regional anesthesia · Education · Simulation · Competency-based learning

Introduction

The current training in regional anesthesia was founded on the apprenticeship model. General surgeons were the first to adopt this model of training approximately 100 years ago to disseminate skills to their apprentices—this coined the well-known statement of learning: *see one*, *do one*, *teach one*. This method of training for the acquisition of procedural skills was adopted across many specialties. However, this methodology has been unable to stand the test of time, especially in the recent years due to a shift in the paradigm of education.

Current Training Methodology and the Need for Change

Inadequate Exposure to Regional Anesthesia

In 1996, the Accreditation Council for Graduate Medical Education (ACGME) and the Anesthesiology Residency Review Committee (RRC) stipulated that graduating residents must have patient care experience with 40 epidurals, 40 spinals, and 40 peripheral nerve blocks [1]. However, in 1999 Smith et al. [2] surveyed 736 anesthesia residents in first, second, and third year of training, to determine how many different blocks they performed and their level of confidence in performing those blocks independently. The number of blocks performed correlated with their level of confidence. By their final year, residents performed about 100 spinals and 150 epidurals, but less than 10 interscalene, femoral, sciatic, and ankle blocks. More than 50 % of final-year residents lacked confidence to perform these blocks. This was similarly shown by Kopacz and Neal [3] when they surveyed all anesthesia programs in 2000, and found that 40 % of the 3039 surveyed residents had inadequate exposure to peripheral nerve blocks to fulfill the ACGME and RRC guidelines. This data revealed that though students were obtaining adequate experience in neuraxial techniques, the exposure to peripheral nerve blocks was disappointing. In recent years this issue has been further

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compounded with a reduction in trainee work hours due to the negative effects of sleep deprivation.

Due to the low number of peripheral nerve blocks performed, anesthesia residents may successfully complete their training, but feel inadequately prepared to continue performing regional nerve blocks, as a trainee needs to perform a certain amount of procedures to attain proficiency. Rosenblatt et al. [4] found that anesthesia residents needed to perform more than 15 interscalene brachial plexus blocks autonomously to achieve a success rate of 87.5 %. Similarly, Konrad et al. [5] reported that 70 axillary brachial plexus blocks had to be performed before an 85 % success rate was achieved.

Lack of exposure to nerve blocks may cause the new anesthesiologist to choose more familiar techniques, such as General Anesthesia (GA) or neuraxial, which may not be the most beneficial for the patient [2]. This will further perpetuate the lack of confidence in performing peripheral nerve blocks, leading to inexperience and loss of skills.

New Technology, New Blocks and New Skills

The advent of ultrasound-guided regional anesthesia brings new skills and techniques to the performance of peripheral nerve blocks. Furthermore, the total number of nerve blocks that can be performed have increased as sensory nerves (adductor canal, superficial peroneal) can now be specifically targeted with the use of ultrasound. Learning surface anatomy alone is no longer sufficient for performing regional anesthesia. The use of the ultrasound requires the development of hand–eye coordination, fine motor skills, and learning sonoanatomy. Such skills cannot be taught by reading a textbook and didactic lectures alone. To perfect these skills, practice and supervised instruction is required. Some of the skills acquired from practice in one block are transferable to another block, for example needle–probe alignment, needle tracking, image optimization, and nerve identification. However, sonoanatomy and potential complications will have to be learned and appreciated for each block.

Change in Learning Environment

As the physician's primary role is for the care of the patient, it has been argued that it is unethical for a trainee to learn procedures on patients, particularly without the consent of the patient [6]. Without prior consent, trainees performing procedures on patients may be considered in breach of that patients' autonomy. Today's patients have multiple comorbidities and they are attending for complex procedures requiring a high degree of expertise by the physicians who care for them. These patients may not be suitable candidates on which one can learn. Furthermore, with the ever-increasing operating room costs, trainees are pressured to perform at maximal efficiency in order to complete more cases. This leaves little time for the trainee to gain expertise in new procedures, and if given the opportunity, the time pressure on the trainee is not conducive to learning or high performance.

Thus, the apprenticeship model of time-based practice on patients is no longer viable as the sole means of acquiring complex skills such as those required in regional anesthesia.

Addressing Changes in the Education Environment

Due to a reduction in work hours, the introduction of new skills in regional anesthesia and the rapidly changing education environment, the clinical learning opportunities for trainees are limited. Therefore, it is imperative that changes are brought to how we learn and teach regional anesthesia. This includes changing the educational model from a time-based one to that of demonstrating competency and proficiency. This model would use simulation, feedback, and evaluation to train anesthesia residents before they have clinical exposure.

Simulation

Simulation training is a means to address the issues with the current training methodology. It offers trainees a non-judgmental, safe learning environment, without any time pressures or patient risk [7, 8]. This has led to the creation of designated simulation centers at many North American university hospitals for teaching surgical skills, crisis resource management in anesthesia, multi-disciplinary team crisis management, as well as ATLS and ACLS. Simulation is also a useful forum for teaching non-technical skills such as communication and collaboration.

Castanelli [8] summarized the benefits of simulation for procedural tasks as follows: learning is focused on the trainees needs, not the patient needs; trainees can focus on the whole procedure or just specific components; it allows procedures to be performed many times in quick succession; it provides a safe environment where trainees can learn from their mistakes; and simulators can provide objective evidence of performance.

The trainee who first acquires psychomotor skills in the simulator is considered a *pre-trained novice*. Thus, when they are tasked with the same procedure in a live patient they dedicate less attention on automated tasks [9], such as needle alignment and ergonomics, and can concentrate on other aspects such as communication and decision making [8].

The benefits of simulation on the acquisition of procedural skills have been demonstrated by multiple studies in the field of laparoscopy, [10–12] which bares similar attributes to regional anesthesia where a 3-dimensional space is transformed into a 2-dimensional image requiring hand–eye coordination in the manipulation of instruments akin to a block needle. Sites et al. [13] demonstrated a 50 % improvement in needling time and needle visualization using a low-fidelity turkey breast model in novice trainees, with as little as three trials. Simulation training has also been shown to translate to improved clinical outcomes. Residents who had 1 h of supervised training on a low-fidelity model achieved a higher incidence of successful blocks, as well as greater proficiency in block performance [14].

Assessment

Traditionally, trainees are graded on their performance subjectively by their supervisors and on review of the procedures the students have performed (log books). However, an assessment tool that is objective, validated, and has a high inter-rater reliability is required. An objective means of assessing performance clinically and on simulators allows for comparison among peers, highlights not only strengths but also areas for improvement, and offers concrete evidence of improvement in performance. Assessment tools for regional anesthesia must assess both technical and non-technical skills. A number of modalities of assessment are available for procedural skills, such as motion analysis, checklists, and global rating scales.

Motion Analysis

Motion analysis is a form of objective assessment of procedural skills. The Imperial College Surgical Assessment Device (ICSAD) is a device that uses an electromagnetic tracking system (Isotrak II, Polhemus, Colchester, VT, USA) and computer software developed by the Imperial College in London, UK. The software (Robotics Video and Motion Assessment Software—ROVIMAS) records video and detects motion with the help of two electromagnetic trackers attached to the back of the hands of the trainee. The device records the number of hand movements required to perform a technical skill and the time taken to complete the task. It works on the premise that as one acquires expertise, the number of hand movements and duration of the procedure are reduced. The ICSAD has been effectively validated in surgical skill acquisition [15] and in ultrasound-guided regional anesthesia [16]. Chin et al. [16] performed construct validation of the ICSAD in performing ultrasound-guided supraclavicular brachial plexus blockade by novices and experts. The study further conducted concurrent validity by having regional anesthesia fellows perform the same block during their first week of training and then during their last 3 months of training. The results demonstrated that the ICSAD could clearly differentiate block operators based on their level of experience. Motion analysis technology is useful for an objective and quantitative assessment, but does not address the quality of the procedure [16] or non-technical skills. Thus, checklists or global rating scales must be used to complement this technology. Additionally, this device will need to be validated for each block prior to assessment.

Checklists

Dichotomously scored checklists appoint a pass or fail outcome for each task in the performance of a procedure. Such checklists must be validated for each procedural skill that it assesses. One flaw with checklists is that each point is weighted equally regardless of its clinical significance [17]. As a result, the trainee may seemingly perform well by obtaining the vast majority of points, but key steps may have been omitted. To circumvent this, the checklist can be created so that omission of one or more key elements results in an overall fail.

Global Rating Scales

Global rating scales tend to examine broad categories, rather than discrete steps, for example procedural preparation and instrument handling. They are less objective because each component is scored on a Likert scale, as opposed to a binary pass/fail. Another potential issue with this assessment tool is that performance in one category may influence the assessors scoring in another category [17]. The benefit of the global rating scale, over the checklist, is that it can be used for different procedural tasks, that is, without validating for every type of block.

Cheung et al. created an ultrasound-guided regional anesthesia (UGRA) assessment tool that comprises both a checklist and a global rating scale [18]. This tool was recently evaluated to establish validity and reliability in both a clinical setting with patients and on a high-fidelity simulation model [19•]. The investigators found that in the clinical setting there was excellent inter-rater reliability; while in the simulation setting there was good reliability. The checklist demonstrated construct validity in the clinical setting, but not with the simulation model. Trainees with little experience in UGRA tended to score lower in the clinical setting. Thus, the checklist result during simulation cannot be used as a surrogate for clinical skills. Further work is required to design simulation-specific checklists. In contrast, the global rating scale did demonstrate construct validity because it was able to differentiate between inexperienced and experienced operators in both a simulation and clinical setting. It should be noted that none of these assessment tools address successful outcome, but merely examine the process of the procedure.

Feedback

It is not enough to simply let the trainee run through a simulation, or practice for an unspecified amount of time on a simulator. The trainee will reach a plateau level and not improve performance with continued practice. Ericsson investigated the requirements to achieve expert-level performance and he found that *deliberate practice* is required. With deliberate practice, improvements in performance have been found to occur when individuals are given specific goals, adequate opportunities for repetition, and provided with feedback [20].

Instructor-led simulation offers the opportunity for deliberate practice in the development of expert-level performance [21]. Feedback has been found to be one of the most important features of simulation-based learning [21]. Feedback from the instructor is a component of the debriefing session. An instructor trained in the use of an appropriate assessment tool should provide feedback prospectively, in an area free from distractions [22•]. The instructor should guide the debriefing session based on how closely the trainee achieved prespecified learning objectives/goals, and suggest modifications of behavior or technique to accomplish the objectives and improve performance. Debriefing allows the trainee enough time for reflection on their performance and subsequent critical analysis, with the aim of incorporating change in their practice [23]. This is the hallmark of experiential learning. Debriefing has been shown to have a significant improvement on the performance of practicing anesthesiologists in a simulation crisis, when scored by a checklist [24].

The Next Step: Looking Toward the Future—Competency-Based Education

In 2009, the ACGME began the process of restructuring its accreditation process to be based on educational outcomes in six domains of clinical competencies [25]. This approach focuses on the trainee achieving specific outcomes, which have been labeled as *milestones*, and in so doing it is not limited by a fixed, time-based training. ACGME and the American Board of Anesthesiology have identified 25 milestones each with five levels that residents must progress through the course of their training [26]. A regional anesthesia milestone has also been developed. The regional anesthesia milestone levels begin with the assessment of basic physiology and the requirements for performing regional anesthesia. By level four, the resident fulfills the expectations of a residency-training program, and is ready to transition to independent practice. Graduating residents are expected to achieve level 4 competency, but it is not yet a requirement for graduation. The rare resident who achieves level five exceeds residency expectations, as they perform at the level of a practicing anesthesiologist. At this level, residents can independently manage complications of regional anesthesia and perform self-evaluation. These progressive levels of competency-based education appear analogous to Miller's pyramid of clinical competence (Fig. 1) [22, 27•].

Program directors have begun the process of transitioning to competency-based education. Will this new method address the issues with the current training method in regional anesthesia? On its own, the competency by design curriculum cannot address the issues of lack of exposure to sufficient number of blocks, ethical and safety concerns with novices practicing on patients, lack of clinical exposure resulting from duty hour restriction, and increasing pressure for operating room productivity. This is where the role of simulation will be invaluable. It will mean creating and investing in simulation models that represent each of the common blocks residents are expected to perform. High-fidelity hybrid models combining a physical model with an MRI-derived virtual interface are under development [28]. Such models are able to display motor twitches, vascular puncture, and provide haptic (sense of touch) feedback as the needle traverses the *skin* and fascial planes.

Program directors and regional anesthesiologists will have to design checklists and global rating scales specifically for simulation, and similar assessment tools for clinical practice. Novice trainees will require that the nerve

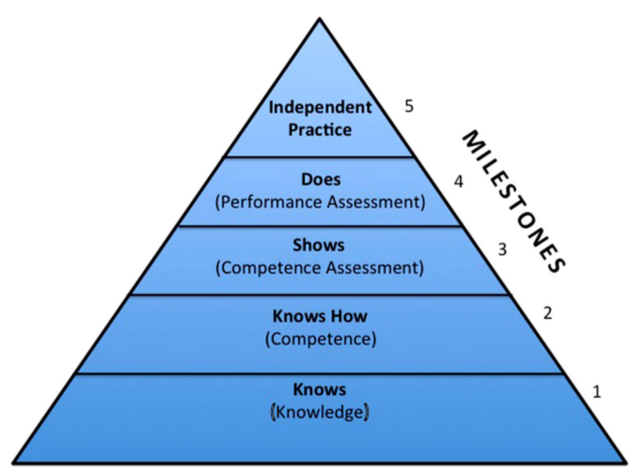

Fig. 1 In Miller's pyramid of clinical competence the base represents knowledge of factual information, followed by the demonstration of skills, the assessment of competence and performance, and finally the peak which represents the ability to assess one's own clinical practice. The independent practitioner, equivalent to level 5 of competency-based assessment, is able to perform self-evaluation and safe practice

block procedure be broken down or "deconstructed" into individual steps [29•]. With practice, these steps become automated and the trainee can focus their attention on other factors during the actual performance of the block on a patient.

Competency by design should address the issue of residents not feeling adequately prepared to perform basic blocks at the end of residency. Residents not progressing through the levels of each milestone will be easier to identify and additional training will be provided. This new paradigm may be difficult for some educators to accept. Some may argue that if it worked for the past 100 years, why change it? But the face of medicine is changing, and the method of teaching must also adapt. Today's anesthesiologist performs numerous procedures both in the operating room and in clinic settings. A rigid time-based program may not allow sufficient exposure to develop skills in peripheral nerve blocks and catheter placement, transesophageal echocardiography, interventional chronic pain procedures such as stimulator implantation, radio frequency ablations, and spinal catheters. Furthermore, objective assessment tools, as fostered by a competency-based system are required to gage performance on these procedures, as opposed to quantitative assessment based on logbook entries. Faculty will have to be educated about the model of competency-based education and be engaged in curriculum development. The implementation of this curriculum requires that educators receive training in observing, using assessment tools, and providing feedback on their trainees' performance.

Conclusion

Surveys have revealed that residents feel inadequately prepared to perform regional anesthesia nerve blocks by the time of graduation. The current model of training has limited opportunities for procedure performance and does not guarantee that procedures are performed well or that complications can be managed. Clearly, the current education model based on the apprenticeship paradigm is no longer adequate for the multitude of procedures trainees are expected to learn.

Simulation allows for development of a *pre-trained novice* who is able to devote more attention to the finer points of the procedure during actual clinical practice. Simulation is part of the solution for the reduced clinical exposure, the unethical nature of practicing on patients, and provides a platform to practice blocks that need improvement. High-fidelity models are required, which are undoubtedly expensive, but less so than cadavers and the cost of causing patient harm.

ACGME has mandated that programs institute competency-based education into the curriculum. This appears to be an objective means of ensuring that each resident is adequately prepared for independent practice. By extension, it should be incorporated as part of a multi-faceted program to teach regional anesthesia, which also includes didactic lectures, observing experts, and deliberate practice involving simulation models.

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Compliance with Ethics Guidelines

Conflict of Interest Reva Ramlogan and Ahtsham U. Niazi declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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