

Review Article

Anaesthesia and education

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A literature review was undertaken to document the status of anaesthetic education in both the peer-reviewed anaesthesia and medical education literature. A search was performed using Silver Platter® for the period 1983–91, and the most widely circulated medical education and anaesthesia journals in North America were reviewed in detail. Although anaesthetists are involved in many educational activities, the literature is oriented towards postgraduate training. Common issues include the assessment and selection of residents. Newer methods of evaluation, for example, daily assessment by preceptors, have been described, but work continues to be needed on these and older methods, such as oral examinations. Selection processes may be improved by incorporating psychological and psychomotor measures in the assessment process. A limited number of teaching methods, especially simulators, have been the focus of much interest, while other methods, such as bedside teaching, have received little attention. Programs of recertification or maintenance of competence, which have been announced by certifying bodies, may place new emphasis on the study of the design, effectiveness, and outcome of continuing medical education. In conclusion, the review revealed that there are many opportunities for anaesthetists to conduct educational research into many traditional and new areas of medical education.

Une revue de la littérature a été menée afin de documenter l'état de l'éducation anesthésique, dans la littérature anesthésique revisitée par les pairs et dans la littérature d'éducation médicale. Une recherche a été menée en utilisant Silver Platter® pour la période 1983–91, et les périodiques d'éducation médicale ainsi que les revues anesthésiques les plus répandues en Amérique du Nord ont été révisés en détail. Bien que les anesthésistes soient

Key words

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impliqués dans plusieurs comités d'éducation, la littérature est orientée vers l'entraînement postgradué. Des intérêts communs incluent l'évaluation et la sélection des résidents. Des nouvelles méthodes d'évaluation, telle que l'évaluation journalière par les instructeurs, ont été décrites, mais il est nécessaire de continuer les travaux concernant celles-ci et d'anciennes méthodes telles que les examens oraux. Les procédures de sélection peuvent être améliorées en incorporant des mesures psychologiques et psychomotrices dans le procédé d'évaluation. Un nombre limité de méthodes d'enseignement, spécifiquement les simulateurs, ont soulevé beaucoup d'intérêt, alors que d'autres méthodes tel l'enseignement au chevet du patient ont reçu peu d'attention. Les programmes de recertification et de maintien des compétences, qui avaient été annoncés par les autorités en certification, pourraient placer une nouvelle emphase sur l'étude de la planification, de l'efficacité et des résultats de l'éducation médicale continue. En conclusion, cette revue a révélé qu'il existe plusieurs opportunités pour les anesthésistes de mener des recherches en éducation dans plusieurs sphères nouvelles et traditionnelles de l'éducation médicale.

Outline

Purpose

Education in anaesthesia

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- What are the most effective teaching methods?
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Purpose

All anaesthetists are periodically involved in educational tasks. These activities range from education of patients, medical trainees and other professionals, to one's own continuing medical education. Peer-reviewed research articles concerning the investigation of educational techniques or outcomes are relatively uncommon in the

anaesthesia literature. The reason for this may be that education is often carried out concurrently with other tasks, for example, providing patient care, and is not frequently viewed as a primary activity.

This review has three objectives: first, to analyze the peer-reviewed anaesthetic literature pertaining to education in terms of major themes; second, to use the medical education literature to identify commonly held views about the future direction of medical education, with implications for anaesthetists; and finally, to identify areas requiring further work.

Education is defined as a process which results in a persistent, predetermined, alteration in behaviour, usually reflected by the acquisition of new knowledge, skills, or attitudes by the learner. This implies recognition of a group of motivated learners, availability of a tool which is effective in changing behaviour, and existence of a measurement tool which can identify or quantitate change. Frequently, the learners are clearly identified. In contrast, information about the effectiveness of teaching methods and the accuracy and reliability of instruments of evaluation are less concrete.

Education in anaesthesia

The basis of this review is a literature search performed using Silver Platter[®] for the period 1983 to April 1991. In addition, the journals *Academic Medicine*, *Anesthesia and Analgesia*, *Anesthesiology*, the *Canadian Journal of Anaesthesia*, *The Medical Teacher*, and *Teaching and Learning in Medicine* were reviewed in detail. The articles identified concern medical education as conducted in North America, the United Kingdom, and Australasia.

As seen below, the majority of articles pertain to graduate medical education, including selection, evaluation, and teaching of residents. Although much material is published in the United States for the continuing education of nurse anaesthetists, this literature is not further reviewed here. The review has been organized into sections based on questions about the process of education.

Whom do we teach?

Little information is available from the peer-reviewed literature concerning education of patients or other health care workers by anaesthetists.¹ In contrast, resident education has been the focus of much attention. Authors have attempted to identify: (a) the characteristics of residents who apply to our programs; and (b) the factors associated with success in the program. Success in anaesthesia education has usually been estimated in terms of quality of performance on certification examinations, knowledge evaluations (for example, the American Board of Anesthesiology—American Society of Anesthesiologists

In Training Examination), oral or written examinations produced by the program, or preceptor assessments.

What type of people apply to our programs? A retrospective survey, which attempted to identify why students choose high technology specialties, found that factors such as income, prestige, research, regular hours, more leisure time, and better call during residency were rated more highly by students choosing non-primary care specialties.² The ability to control hours of work appears to be an increasingly important factor in specialty selection for recent medical school graduates.³ The stereotype that students with certain personality characteristics are attracted to interpersonal or person oriented specialties, while others with more technical orientation are attracted to technologically oriented specialties, does not seem to be valid.⁴

Can residents, who attain the measures of success identified above, be recognized at the time of application? Several studies have attempted to identify the characteristics possessed by such individuals. These studies have often focussed on the usual academic measures; for example, test scores and grades.^{5,6} Personality factors have also been found to be important in the prediction of success. In one study, the 16PF Personality Questionnaire, a widely used measure of personality traits, was compared with preceptors' rankings of a group of residents. Using stepwise discriminate function analysis, 11 factors were identified which when taken together predicted the "best" and "worst" residents as identified by their staff.⁷ The most important factors were social skills, assertiveness, sensitivity, and emotional maturity. Nevertheless, formalized personality assessment does not appear to be a commonly used tool in Canadian residency programs.

Similarly, measurement of motor skills appears to be an infrequent part of our selection process but has been applied in a surgical program.⁸ In this study, a variety of dexterity tests employed by occupational therapists was used to see if they could predict surgical skills of orthopaedic residents (as measured by faculty ranking). Two tests, the Crawford small-part dexterity test and the steadiness hole test, correlated significantly with faculty rankings. While motor skills may be less important for anaesthetists than for orthopaedic surgeons, studies of the importance of motor skills to both selection criteria and ultimate success in practice are required.

Methods have been described to help programs rank their applicants.⁹ Information from pre-interview screening, and interview evaluation can be stored in microcomputer databases, allowing searching of various fields of information and assisting in the final ranking process. Others have reported on the discriminatory power of various parts of their database (for example, the Dean's

letter, course grades, references, etc.)* In most cases, weighting systems appear to be rudimentary and lack assessment of psychological and motor skills. The applicant is not a passive element in the selection process but discriminates between programs on the basis of factors such as perceived resident morale, general impression at interview, diversity of training experience, and geographic location.^{10,11}

While the relevance of anaesthesia to the undergraduate curriculum is periodically questioned, its presence has been justified by the teaching of resuscitation skills, pain control, and medical management during the perioperative period.¹³ Programs describing anaesthetic-related teaching of medical students are sparsely reported in the literature, although the importance of undergraduate education, if only for the partisan objective of future recruitment into the specialty, has been emphasized.¹²

Continuing medical education (CME) has also received little direct attention in the anaesthetic literature (although new programs of recertification and maintenance of competence which are being developed by the American Board of Anesthesiology and the Royal College of Physicians and Surgeons of Canada may encourage future development). A recent review article identified pertinent research questions for CME which included "what, how, and why physicians learn and change; how better programs can be designed ... ; and in what ways the organizations that provide CME can or should differ in their policies, procedures, and resources."¹⁴ The latest developments in CME seem to place greater emphasis on the individual requirements of practitioner-learner and relate more specifically to the needs of practice. To match this change in emphasis, a wide variety of new educational approaches are available, including: "practice protocols, peer-comparison feedback, practice audit, one-on-one teaching by academic detail persons, small-group tutorials, and more traditional workshops."¹⁵ These techniques emphasize individualized assessment and teaching, learning driven by the needs of clinical practice, learning motivated by peer-review, and assessment of educational need by comparison of care provided with that in established protocols. Many of these techniques are new and further research is needed to define specific indications and effectiveness of each method. There are no reports of application of the newer techniques to anaesthesia.

What do we teach?

In Canada, the curriculum of anaesthetic education has

*Gilbert G, Erian RF, Yuan C, Wahl D. Evaluation of the discriminating power of the components in a resident applicant scoring system. Presented at the Society for Education in Anesthesia's Annual Spring Meeting, Quebec, 1991.

become the domain of the residency programs. The Royal College Standards of Accreditation require each residency program to have educational objectives.* In the absence of a formalized, national set of objectives, each program has developed its own. In the 1970's, initial efforts were made to define a curriculum of anaesthesia, but formal educational objectives were not produced.¹⁶ In most systems, evaluation is based on the educational objectives provided to the learner. While the absence of nationally accepted objectives allows each residency program the flexibility to adapt its educational program to its own clinical and research resources, a less desirable effect may be incongruence between the local curriculum and the Royal College examination process.

What are the most effective teaching methods?

While much teaching remains didactic, considerable interest has been shown in newer methods of learning, particularly simulators. Simulators may be divided into three classes: comprehensive, computer models, and manikins.

Comprehensive simulators are analogous to the pilot's cockpit simulator. Several different systems have been described in detail.^{17,18} The most sophisticated simulators include a simulated patient, an anaesthetic machine, ventilator, and monitoring equipment. Intravenous fluids can be administered and medications injected. Appropriate physiological responses, which may be determined automatically by microcomputer or directed by the human operator, can be displayed on the monitors. The advantages of these simulators are numerous: (1) they mimic the working environment (face validity); (2) they allow situations to evolve without intervention by another physician or harm to a patient; (3) problems can be attempted several times by the same trainee, or by several trainees in succession; (4) problems that are rare in clinical practice can be attempted as frequently as necessary; (5) the ability to record the trainee's responses enables exacting feedback; and (6) problems can be stopped, restarted, and restructured.

Despite these apparent advantages, there are as yet no studies which demonstrate a clear advantage to the use of simulators in anaesthesia. While it might be expected that trainees who have experienced "catastrophic" problems in the simulator may perform better than simulator-naive trainees when faced with similar "real life" critical situations, the rarity of such events in practice would make this difficult to study. In sum, both observational and experimental studies are needed to determine the indica-

*The Royal College of Physicians and Surgeons of Canada. General Standards of Accreditation. Ottawa, 1989.

tions for use of simulators, their optimal design, and their effect on clinical skills of trainees.

Cost is a major problem limiting widespread utilization of these devices. Comprehensive anaesthesia simulators are expensive, both in capital expense and in time invested by computer programmers and physician designers. Some of the capital costs may be offset by using Operating Room anaesthesia equipment, but since no "off the shelf" systems exist, acquisition of a simulator remains expensive. Cost effectiveness is also limited by the ability of the simulator to accommodate only one student at a time. The design of the simulator limits both the number of clinical situations it can emulate and the diversity of responses allowed the trainee. For example, it is not possible to utilize a transvenous pacemaker on most manikins.

Other areas of medicine have also attempted to find simulators having high "face validity." The advantages identified for simulators are also pertinent for standardized patients, which are now extensively used for instruction and evaluation in undergraduate medical education.¹⁹ In anaesthesia, there is no reported use of standardized patients, although they might be used to teach topics such as preoperative assessment, management of medicolegal problems, and communication with family members about adverse events.

Computer simulators lack the ability to recreate accurately the work environment found in the comprehensive models. Nevertheless, computers can allow reproduction of complex clinical problems, and responses of the trainee can be recorded and timed. Errors can be identified and summarized following the encounter. An example of this type of program is the Anesthesia Simulator-Recorder, which allows a number of clinical problems to be attempted in an interactive environment.²⁰ Problems include an obstructed endotracheal tube, bronchospasm, and anaphylaxis, among many others. This program is designed to run on an IBM AT compatible microcomputer and includes physiological and pharmacological modelling systems. Other computer simulations have been less ambitious and have attempted to teach only part of an anaesthetic problem; for example, uptake of anaesthetic vapours (Gas Man).²¹ In a more general context, the National Board of Medical Examiners has developed computer-based examinations based on similar principles which may become components of the certification process.

A major advantage of computer simulation is the relative cheapness of acquiring an "off the shelf" system. In contrast to the comprehensive simulators, computer simulations do not require an attending supervisor and can be used at any time. Current systems allow only one user to use the system at a time, but use of multi-tasking computers in networks may allow several simultaneous,

independent users. There are considerable possibilities for future development. For example, interactive systems have been developed which link the computer to stored videodisc images.²² These images can be either "still photographs" or short video segments. There is no reported use of this type of technology for teaching in anaesthesia, although it is widely used elsewhere.

Software programs are available which allow computer-based instruction to be developed easily and relatively rapidly. Some of these, for example Authorware Academic, are highly visually oriented, allow animated images to be created, and can interact with images and information stored on videodisk.* There are no reports of application of this type of program to anaesthesia.

Manikins are the least technologically sophisticated form of simulation and are used for teaching manual skills, most commonly epidural catheterization and fiberoptic bronchoscopy.²³⁻²⁸ Most studies have described the manikin used and demonstrated that improvement in skills can be achieved. There is little which compares the rate at which skills are acquired or retained on one manikin versus another.²⁹ Also, there are few studies which compare the effect of simulators to more traditional forms of teaching and learning. Manikins may be useful for orientation and practice of technique, but may offer little advantage over traditional one-to-one clinical teaching in the long term. This does not imply that simulators do not have a role, but that more comparative studies are needed.

Bedside teaching has been the subject of much investigation in internal medicine, but relatively little is known about the most effective operating room teaching.³⁰ Study of effective clinical teachers has led to a model of teaching based on a series of critical steps.³¹ The first step is recognition of the learner's level of development or training. Next, expectations or objectives should be set for the encounter. The learner may then be questioned in a problem-solving fashion about the clinical case. Evaluative questions may help to probe the learner's comprehension and give direction to the teaching. Feedback from the student should be elicited, and finally, a summary of what was learned provided. This type of teaching requires the instructor to have both a high level of interest in the development of the student and mastery of knowledge in the area of interest.

How do we measure the effectiveness of our teaching?

Evaluation of trainees generally falls into three categories: written examinations, oral examinations, and in-training assessments. The American Board of Anesthesiology/American Society of Anesthesiologist's annual multiple

*Authorware Academic is produced by the Apple Canada Education Foundation, Toronto, Ontario.

choice examination is probably the most widely used instrument in North America to assess residents' knowledge. Analysis of results of this examination can provide detailed information about candidates' depth of knowledge across subspecialty areas and identify areas of deficiency for individual residency programs.³² This information can be used to restructure teaching programs when required. Perhaps because of the widespread acceptance of this examination, little has been written about other forms of knowledge evaluation.

Oral examinations are components of the certification process of both the Royal College of Physicians and Surgeons of Canada (RCPSC), and the American Board of Anesthesiology (ABA), and are a frequent form of evaluation in residency programs. Despite a few studies demonstrating excellent reliability in certain formats, most authors have not found oral examinations to have adequate reliability or validity.³³⁻³⁵ Although oral examinations are commonly used and have well documented deficiencies, the relevant anaesthetic literature is sparse. Areas requiring investigation include the effect of examiner training, personality issues, and case specificity of performance. Studies suggest that oral examination results do not correlate with other measures of resident performance, including preceptor evaluation, and knowledge evaluation.^{34,36}

Others specialties have attempted to address these concerns of reliability and validity by modifying the oral examination. Chart-stimulated recall is an oral examination technique which uses preselected case files from the candidate's practice which are used to frame predetermined questions.³⁷ This alters the format of the oral examination substantially by adding much greater structure. (The type of case, questions, and acceptable answers are planned in advance; the candidate is dealing with a "real" case, with which he or she is familiar.) Although Chart-stimulated recall has not been utilized in anaesthesia to date, it may lessen some of the concerns about the deficiencies of traditional oral examinations.

In-training evaluations are a component of the RCPSC certification process. Based on the belief that daily work provides a rich pool of material for assessment, Rhoton and coworkers have developed a system of evaluation which requires attending physicians to complete a daily evaluation form which records whether the resident performed as "expected," or above or below expectations. Specific comments are also recorded and critical events can be classified into 28 categories. This information is computer-stored and periodic reports can be used as a basis for discussion of performance.³⁸ Advantages of this type of assessment are that poor performance noted on a particular "bad day" can be discriminated from persistent

deficiencies requiring intervention, and repetitive problems arising between a particular staff person and resident can be identified. In centres where this type of system has been used, it has been found "to promote early intervention and correction for residents who demonstrate weaknessess."³⁹

Can we improve the effectiveness of teachers in anaesthesia?

The scarcity of anaesthetists with formal training in education may limit our effectiveness as teachers and researchers of education. Other areas of medicine, especially academic family medicine departments in the U.S., have implemented faculty development programs to enhance the teaching skills of their faculty members.⁴⁰ A faculty development program has been described in an academic anaesthesia department which utilises a professional educator for staff development and assistance with educational matters.⁴¹ Faculty development for anaesthetist-educators has long been an objective of the Society for Education in Anesthesia.

Future directions in medical education

Undergraduate medical education in North America is under intense scrutiny and pressure for change.⁴²⁻⁴⁴ The major themes of this criticism have been reviewed and can be summarized: medical education must place greater emphasis on learning than on teaching; on students than on teachers; on problem solving than on fact-recall; on the community than on its hospitals; and on disease prevention than on illness.^{40,45} These criticisms reflect the opinions of a wide body of medical educators and interested groups (such as the Josiah Macy Foundation and Royal Society of Medicine Foundation*). Anaesthesia comprises an acute care, hospital-based specialty. A major shift of the focus of medical education toward preventive medicine in a community setting could have significant effects on the resources available for anaesthesia education, especially in this era of financial limitations. We may face increasing competition for teaching time in undergraduate programs, numbers of residency education positions, and program funding in the future.

In contrast, CME may offer new opportunities for anaesthetists interested in education. Although the RCPSC and ABA appear to be taking different directions (either maintenance of competence or recertification) both systems emphasize the need for continuing education (see

*Royal Society of Medicine Foundation/Macy Foundation Conference. Medical Education in Canada, the U.K., the U.S.A., and Australia: the medical school's mission and the population's health. 1991 (Unpublished).

TABLE Recertification in the United States and Canada

Feature	American Board of Anesthesiology	Royal College of Physicians and Surgeons of Canada
Name of program	Continued Demonstration of Qualifications (CDQ)	Maintenance of Competence Program
Cooperating groups	American Society of Anesthesiology	Canadian Anaesthetists' Society
Components	<ol style="list-style-type: none"> 1 Evaluation of current performance <ol style="list-style-type: none"> (a) documentation of peer review (b) freedom from chemical dependency (c) description of current practice (d) unrestricted license to practice (e) quality assurance review 2 Written examination 3 The initial certificate will not be time-limited. 4 Upon successful completion of CDQ a further certificate will be issued 	<ol style="list-style-type: none"> 1 Self-directed education (40 points maximum) Journals, conferences, rounds, self-assessment program 2 Learning objectives based on peer evaluation (30 points maximum) Case recall interviews, OSCE, quality assurance, orals 3 Scholarly contribution (20 points maximum) Education, research, publication 4 Minimal requirements: 80 points over a 5-year cycle

Table). *† The Maintenance of Competence Program of the RCPSC (MOCOMP) is designed to be flexible and non-coercive. It is based on a framework composed of contributions from self-directed education, peer evaluation, and scholarly contributions. Of note, credit points are to be based on participation in activities and not the results of examination. The ABA system differs by including a certifying evaluation of basic and relevant subspecialty knowledge. It can be expected that initiation of these programs will not only encourage greater involvement of practitioners in CME activities, but also stimulate new investigations into the cost-effectiveness and efficiency of various modalities of CME. Educators are already addressing some of these questions.^{14,15}

Conclusion

It can be seen that there remain opportunities for anaesthetists involved in education to study the effectiveness of educational methods and evaluation systems. With the development of new systems of MOCOMP and recertification, there is an impetus to develop new systems which analyze practitioner requirements, and the cost-effectiveness of educational programs. On a larger scale,

*The Royal College of Physicians and Surgeons of Canada. Maintenance of Competence. Ottawa, 1990.

†Eggers GWN. Continued demonstration of qualifications. ASA Newsletter 1990; 54: 4-6.

pressure on medical schools may result in additional competition for the resources used by our programs. Rigour in the design, evaluation, and documentation of our educational programs will aid their defence.

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