Facilitating Research Projects in Schools and Clinical Respiratory Care Departments

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As the profession of respiratory care evolves, greater demands are being placed on educators, managers, and practitioners as they encounter a mass of new literature and the latest technology. Respiratory care schools and clinical departments are under increasing pressure to prepare students and staff with the skills needed to efficiently and effectively consider the numerous primary research investigations, systematic reviews, consensus practice guidelines, and institutional continuous-quality-improvement data. A classroom and work environment that encourages openness and discussion and rewards inquiry is of fundamental importance. Cooperative efforts from school and workplace can provide both student and practitioner with courses on scientific methodology, journal clubs, and equipment seminars. A student body and clinical staff that receive foundational and ongoing education in empirical methodology will respond by assisting in the development and implementation of practice protocols, quality assurance programs, and clinical research. A school and workplace that embrace these attitudes and practices will provide an environment that enhances learning, stimulates professional development, and ultimately provides the most current and best care for its patients. *Key words: research, respiratory care, research methodology, motivation, medical education, teaching.* [Respir Care 2004;49(10):1199–1205.

If you don't ask the right questions, you don't get the right answers. A question asked in the right way often points to its own answer. Asking questions is the 'ABC' of diagnosis. Only the inquiring mind solves problems.

—Edward Hodnett

Introduction

Respiratory care is a profession that has evolved from conducting limited, task-based, technical functions to performing an array of services that require more complex cognitive abilities and patient-management skills. An information explosion and consequent changes have promoted clinical practice that is based on the scientific method. The larger theme is to use "hard science" or "best evidence" to establish the basis for clinical practice. Respiratory care involves complex decisions, as evidence, expertise, and clinical values are applied in patient care.

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Table 1. Resources for Medical Literature Review, Statistics, and Evidence-Based Medicine

Centre for Evidence-Based Medicine, University Department of Psychiatry, Warneford Hospital, Headington, Oxford, United Kingdom, OX3 7JX. http://www.cebm.net
BMJ Publishing Group Ltd, assisted by Stanford University's HighWire Press. http://ebm.bmjjournals.com
Evidence-Based Medicine Resource Center at the New York Academy of Medicine Library, 1216 Fifth Avenue, New York, New York. http://www.ebmny.org
Evidence Medicine Toolkit. Buckingham J, Fisher B, and Saunders D. Available at http://www.med.ualberta.ca/ebm/ebm.htm
Center for Evidence Based Medicine at Toronto General Hospital, Toronto, Ontario, Canada. http://www.cebm.utoronto.ca
University of Massachusetts Medical School's Evidence-Based Medicine (EBM) Web site (a collaboration of the Lamar Soutter Library and the University of Massachusetts Medical School's Department of Family Medicine and Community Health). http://library.umassmed.edu/EBM

The movement toward a systematic approach to decision making, continuous quality improvement, outcomes research, and evidence-based medicine (Table 1) are responses to the increasing complexity of health care delivery and an overwhelming volume of research.[1–8] These approaches involve attempts to systematically solve patient care problems, the common goals being better health care delivery and better use of resources. Evidence-based medicine attempts to integrate pathophysiologic principles with clinical experience and valid current clinical research data within a human context.

Important job skills for respiratory therapists include being able to evaluate research with critical thinking, to understand research study designs, and to participate in research projects. These abilities help clinicians to stay well informed, to maintain a healthy skepticism, and to use critical thinking in making clinical decisions. Looking for the truth and passing on the art and science through teaching, mentoring, and contributing to professional journals are professional attributes. This article discusses the teaching and learning of research methods and describes education and clinical practice as a continuum. We will review approaches to facilitate positive attitudes toward a scientific approach to solving clinical problems in respiratory care and the development of research projects in both respiratory care education programs and clinical departments.

Rationale

It is a challenge for educators and managers to facilitate this "new age" approach to patient care for current and future generations of respiratory therapists**.** It involves initially establishing new attitudes and skills in students entering the profession, and further enhancement of these attributes among current staff. Traditionally, both education and staff development were based on a "hand-me-down" approach. More senior faculty or departmental staff would pass down the traditions that they had learned in school, from textbooks or equipment manuals, or from their personal observations and experience, and that information would be used in local clinical practice. That education system led to substantial practice differences among education programs and among clinical institutions. Those practice differences became more obvious as researchers began to conduct large, multi-center clinical trials in the pursuit of high-level evidence. Beginning in the 1980s there was an increasing demand to explain practice differences, to better manage data from the information explosion that followed the advent of computers, and to contain medical costs. Those demands led to evidence-based medicine and outcomes-based research. Research in medical education has led to a better understanding of the acquisition of expertise and problem-solving skills.[9] During the 1990s the accreditation of respiratory care education programs also became based more on graduate outcome than on process.[10]

Research-Oriented Curricula in Respiratory Care Education

It is a logical approach to expose students to research as they begin their formal education in respiratory care. Such a curriculum plan would implant the value of the research method as students learn to perform patient physical assessment and to interpret laboratory data, imaging findings, and protocols and procedures. The information explosion has provided an abundance of content, but it has also created a need to develop skills as managers of information. Students now must be able to use computerized databases, to critically evaluate new information with healthy skepticism, and to determine if research findings are clinically important. This new process is quite complex and is influenced by a multitude of factors. Learning theories acknowledge the importance of imparting knowledge/expertise and the context and education environment. The education process can also be affected by the student's preferred learning style and life experiences.[11] The teacher's role as a model and mentor for students is one of the most powerful variables in conveying the importance of a research approach and research in general. Of course, a respiratory care education program's curriculum is important in establishing goals and objectives for the graduate's education outcome. We believe the curriculum should support the development of research skills, in hopes that graduates will get involved in research during their professional careers.

In a traditional content-oriented format, students can be successful in school by just memorizing material and pass-

ing tests. We support education that promotes attitudes and skills that will propel students to continue learning and to continually integrate new knowledge throughout their careers. Respiratory care program advisory committees and college/university planning groups can design their programs and employ learning strategies that support those graduate attributes. Selecting techniques that foster a scientific approach tends to support problem-based learning, which is more learner-oriented. With problem-based learning the faculty tend to act as facilitators, guides, and mentors, rather than merely as sources of information. Problem-based learning strategies tend to develop a more adult learning approach that is supported by mutual trust, freedom of expression, and sharing of responsibility for planning and conducting education. Problem-based learning is consistent with "constructivist" principles, which include: (1) interaction with the environment, (2) stimulation using cognitive conflict, and (3) support of negotiation and recognition of different learning styles. There is some evidence that this strategy allows students to better transfer learned concepts to new problems. Problem-based learning can be integrated into existing courses or clinical practicums, or problem-based learning can be the foundation for developing an overall curriculum. Strategies such as research projects promote interaction between the school and clinical sites, which can assist students in the transition from student to clinician as well as enhance continuing education of clinical faculty.

There is some evidence that problem-based learning may have advantages over traditional, content-based education, in both general undergraduate and medical education.[12–15] However, studying the effectiveness of an education strategy is complex, and there are few high-level, randomized controlled studies of the relationship between education strategy and student outcomes such as knowledge, attitude, and performance.[16,17] It is difficult to separate educational variables when analyzing other non-problem-based learning strategies. Approaches that offer more interaction may receive high marks in participant evaluations, but those approaches *may* only be more *satisfying* (than traditional formats) to participants; they do not necessarily improve learning outcomes.

Conducting research and teaching research skills has long been an established goal for graduate and medical schools.[18,19] Now teaching research skills is increasingly a part of undergraduate programs. Teaching students to critically review research evidence, appraise the process and methods, participate in scientific studies, and put the research findings in clinical context connects classroom to practice. Teaching strategies should foster the development of curiosity, healthy skepticism, awareness, reflection, analysis, honesty, and the skill of fair argumentation. Clinicians are increasingly being asked to be intelligent consumers of research. A liberal arts background is valuable. Access to and a command of the medical literature, and a desire to continue to read critically are of key importance. Schools should use education strategies that develop laboratory research skills, with simulated patient management problems and clinical practicums. Table 2 lists key student research skills. Both respiratory care and nursing education programs have successfully used research as a teaching strategy. Physician and respiratory care faculty are important role models, mentors, and facilitators.[20–23]

Table 2. Student Research Skills

Perform searches for medical literature
Review literature related to a specific problem or area of respiratory care practice
Determine a research hypothesis and reformulate questions with appropriate outcomes that relate to clinical practice
Appraise research methods as to their being appropriate to answer hypotheses
Conduct "project management" in outlining the research plan
Collaborate with a group in delegating project work activities
Conduct a pilot study
Select statistical tests
Write a proposal to the institutional review board or other authority
Collect data and prepare a research database
Manipulate data with statistical methods appropriate for the research approach
Review results and synthesize information to determine research question
Prepare an abstract for presentation or a written report for submission

Several years ago, our respiratory care program redesigned a seminar course on scientific method, research design, and statistics, which we offer to second-year students in our associate degree program. The goals were to enable students to present a case study, to critically review professional literature, to understand research designs and basic statistics, and to conduct a class research project. We considered one measure of success the acceptance of an abstract to the OPEN FORUM at the International Respiratory Congress of the American Association for Respiratory Care.

The literature review was conducted in a journal club format, and the didactic components of the course were in a problem-based-learning format instead of lectures. After the case study series, journal articles were selected that demonstrated the various levels of evidence in peer-reviewed professional journals, including a bench test, evaluation of a new device (procedure or drug) in a multicenter, randomized clinical trial, and a meta-analysis. During the seminar's journal club discussions, students were asked to identify the null hypothesis and diagram the study design. Faculty reviewed statistics as necessary. Students were furnished with a textbook on research, and other resource books were kept on reserve in the library.[24–27] We allowed time at the end of the seminar for the group to

discuss their group project. In each class there were always at least a few students who seemed to stimulate the group's thinking. Most often they reflected on equipment and procedures they had seen during clinical practicums. Problems identified in journal articles also seemed to plant seeds for potential projects.

Many of our students have shown a knack for finding unanswered questions in respiratory care. The faculty helped them select research that was logistically feasible and could be conducted within the final 7 weeks of the course. After a topic was chosen and an initial literature search was conducted, project management was initiated. The class was divided into work groups, timelines were set, and resources were located. Every student participated in the scientific method, including hypothesis generation and study design. The medical director helped with the research protocol and coached students through tasks of data collection and analysis. The entire group was involved in the process of writing and editing the abstract.

For each class the "buy-in" was a key component, after which the process became a "labor of love." It was their project—not the faculty's. It was an active and interactive learning process that promoted critical thinking, curiosity, healthy skepticism, awareness, honesty, and the skill of fair argumentation.[28,29] It also promoted the skills of teamwork, and all the participants came to realize and respect the tremendous amount of work involved in performing high-quality research. At the graduation ceremony each participant proudly received a copy of the final abstract with the diploma and certificate of completion. Since adopting this strategy, these seminars have had 8 consecutive accepted OPEN FORUM abstracts.

Our program has been challenged to include a growing list of desired graduate objectives within the constraints of a 2-year associate degree format. After confirming that our goals and expectations were consistent with local and regional managers, we began expanding our curriculum to a baccalaureate degree format. The above-mentioned seminar course will be offered to third-year students. However, the new 4-year curriculum includes a formal course in research design and statistics, independent research, and contributing to professional journals. We expect 4th-year students to conduct individual research projects, with support from faculty and clinical mentors. We believe that research-oriented learning is congruent with the professional demands graduates will encounter in their careers and that it will therefore improve their career success and job satisfaction, and improve patient care.[30]

Research-Oriented Curricula in Clinical Departments

Within their departments and institutions, medical directors, managers, and clinicians can help promote a positive attitude toward outcomes research, evidence-based medicine, and continuous quality improvement. Managers of respiratory care departments that affiliate with schools can provide key input to advisory committees. The willingness to affiliate with respiratory care education programs and support student research projects demonstrates a positive attitude to both existing staff and future employees. This sends a powerful positive message that intellectual curiosity, scientific methodology, and an evidence-based approach are valued.

Table 3. Categories of Research

Research That Focuses on Science, Diseases, Equipment, or Procedures
Basic research
Applied research
Clinical investigation
Clinical trials
Research on accuracy of diagnostics or efficacy of therapeutics
Evaluation of new equipment
Education research
Outcomes Research and Evidence-Based Research
Clinical
Economic
Humanistic
Internal or External Benchmarking

(Adapted from Reference 27.)

Table 3 lists major categories of research that can be considered for review by respiratory care departments. Managers are charged with providing cost-effective care based on state-of-the art science, with qualified personnel, and with a system for continuous quality improvement. Research to monitor the department's efforts to provide high-quality care, to assess available resources, and to detect and correct deficiencies should be part of an organized departmental administrative framework. This organized process is mandated by the Joint Commission on Accreditation of Health Care Organizations. The scientific approach is continuously applied in a cyclic pattern to clinical work, as steps in planning goals or objectives, implementing projects, assessing problems, and acting to improve results.

There should be both an institutional and a departmental strategy for research for quality improvement. Academic medical institutions have institutional review boards that consider, approve/disapprove, and oversee research to ensure that it is ethical, properly conducted, and that the research's benefits outweigh its risks. There should be a similar research infrastructure in non-academic and community hospital settings. The United States Department of Health and Human Services oversees regulation of federally funded research. Institutional review boards include clinicians, managers, administrators, and legal staff.

Respiratory care departments should be involved in the research infrastructure. Obtaining approval for a research

Table 4. Template for Reviewing a Research-Article in a Journal Club

Identify and critique the study's:
Purpose or objective
Hypothesis and research question
Background/review of previous reports on the subject (were previous reports reliable and valid?)
Study design
Methods: sample size, data collection process, statistical tests, data analysis
Findings
Application and implications, including implications for future research

project often depends on the support of a physician and/or medical director of respiratory care. Clinical research must be pre-approved by the institutional review board. Some institutional review boards require notification prior to publication of non-research such as case reports.

Other components of the research infrastructure include technical support staff, clinical investigators, full-time scientists, statisticians, departmental libraries, computers and software, and funding for travel, education, and/or presentation of research.

Most institutional review boards do not require approval for bench testing or bedside evaluation of FDA-approved new equipment, because such equipment assessments are considered tests of a manufacturer's claims about a product, the effectiveness of the product, or of clinical acceptance by staff therapists. Such research is usually viewed as internal "benchmarking." Some institutional review boards appreciate or even require being notified if a researcher plans to publish his or her results outside of the institution.

Managers of respiratory care departments should consider allocating research funds for human resources, travel, equipment, and space. To foster research, department managers can begin with approaches that foster understanding of the scientific method, evidence-based medicine, professional medical literature, and research methods, including statistics. One good strategy for that is a journal club, in which the participants learn how to critically appraise scientific reports, maintain their expertise, and update and advance their professional knowledge to improve their practice. In 1875, at McGill University, Sir William Osler may have been the first to use the journal club approach, and it has been widely used since then with medical students, residents, and fellows, as well as in training nurses and respiratory therapists.[21,31–40]

The journal club is an active learning strategy that continually allows practice of skills and is usually supervised by an expert. The focus is on question development and critical appraisal of research. Table 4 shows a template for a journal club review of research. Table 5 lists questions the individual should ask while reading a scientific report.

Table 5. Checklist for Reading a Medical Research Report

Journal
Why are you looking at this journal?
Is it reputable?
Is it peer-reviewed?
Article
Why are you looking at this article?
Title
Does this topic apply to your current or likely future clinical practice?
Does it make you want to read further?
Authors
Where are the authors from?
Do you know of them?
What are their credentials?
Funding
Who funded the research?
Could there be a conflict of interest?
Abstract
The abstract is a "mini paper." Is it well written?
They are giving you their "best shot": How did they do?
What are the null and alternative hypotheses?
Introduction/Background Section
This should be a "mini-textbook" update on the subject. Does it give enough information?
Methods Section
This describes what the researchers did (what's taking place "under the hood")
Does it "*fly*" or not?
Make a "thumbnail sketch" of the methods. Did the researchers describe the study as: double-blind? randomized? controlled? cohort?
What/who are the subjects/study group? What inclusion and exclusion criteria were used?
Was there informed consent and/or animal care precautions?
What were the interventions?
Were statistics properly used? (eg, *t* test, analysis of variance, chi-square, regression analysis, multivariate analysis)
Was the study biased?
Results Section
Study the tables and figures. Concentrate on the statistically significant differences and findings.
Are the statistically significant differences also clinically important?
Do the authors give enough reason to reject the null hypothesis: Was a power analysis performed before the study was started?
Discussion Section
Do the authors explain how their results advance our understanding of a medical question, problem, or issue?

A research mentor* plays a key role in helping the novice learn the research process and in guiding the research to publication. A good mentor provides assistance with

* The word "mentor" comes from the ancient Greek story of Odysseus. While Odysseus was away on his 10-year journey, his friend Mentor taught, advised, and protected Odysseus's son, Telemachus.

each phase of the research process, including helping the student: to select and acquire appropriate equipment and technical resources, to apply for funding, to obtain institutional review board approval, to work with a research team, and to make decisions during the research. A mentor can offer feedback, provide moral support, exhibit enthusiasm, and foster a positive work relationship with the protégé.[41] Nonphysician researchers who are involved in clinical trial research, case management of protocol participants, grant and budget development, and/or report preparation can become certified as research professionals. The Society of Clinical Research Associates is a national organization and information clearinghouse that promotes training in research and offers certification.[42] Institutions that do not have research mentors can invite mentors from other institutions to lecture and conduct workshops on research, and the relationships thus established can be continued through fellowships, internships, or periodic contacts at the mentor's institution.

The American Association for Respiratory Care supports the professional development of beginning researchers by way of the OPEN FORUM, at which abstracts and posters are presented. Some state societies also support poster presentations at their annual or quarterly meetings.

Summary

We urge educators and clinic managers to support and encourage students and clinicians to acquire the skills of scientific investigation, especially critical thinking, by creating an environment that supports scientific methodology, openness, curiosity, and examination of existing and proposed clinical practices. A commitment to teaching research methods and evidence-based medicine is the foundation for the continued growth and improvement of the respiratory care profession.

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Ida A Bengston in laboratory's sterile room
transferring tissue cultures of Rocky Mountain
spotted fever (old negative).
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