Problem-based learning as a training modality in the occupational medicine curriculum

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Problem-based learning has been used as a curricular modality in the academic year of the Occupational Medicine Residency Program. The method was applied to the resolution of problems presented by patients referred to a university clinic specifically for the determination of possible work-relatedness of the syndrome or symptoms presented. Following the usual development of the occupational and medical histories, physical examination, and determination of certain clinical laboratory values, the resident would then have to seek assistance through consultation with related specialists, a perusal of the pertinent toxicology, epidemiology, or other discipline literature, and ultimately prepare a university-level report, following case conferences with fellow residents and faculty members. No formal direction was given the student, the problems of diagnosis, occupational etiology and medicolegal acceptance of the resulting report having to be resolved through self-perusal of informational sources. The knowledge gained from the exercise would be longer-lasting than that attained strictly from lecture attendance.

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"Let the purpose of this, our dialectic, be to discover and to use a method of instruction by which teachers teach less and learners learn more."

—John Amos Comenius (1592–1670)

Specialized graduate education in occupational medicine was initiated in the United States shortly after the conclusion of World War II, different degrees being granted by the few institutions offering such programmes. By the 1960s, some comparability in curricular content was seen, meeting mandates prescribed by the American Board of Preventive Medicine, targeted primarily toward fulfilling the requirements for the Master of Public Health degree.

By the late 1970s, the Educational Resource Centers supported by the National Institute for Occupational Safety and Health (NIOSH) began to emerge in selected universities, and many young physicians entered and completed the Residency Programmes in Occupational Medicine. Currently there are 41 programmes approved by the Accreditation Council for Graduate Medical Education (ACGME)*, based primarily in both State and private universities; two are located in large hospitals; and two are associated with the Armed Services. The programmes are found in 28 of the 50 States and in the District of Columbia, and are associated either with a School of Public Health or a School of Medicine.1

The curriculum comprises three postgraduate years, the first being a year of supervised clinical training provided as part of an accredited residency or internship programme involving direct patient care. Many of the physicians entering the occupational medicine residency will have had the clinical year's experience in Family Medicine (Primary Care). The second year is the academic year, the course content including

*The ACGME is a private national body that accredits postgraduate medical education programs, usually termed residency training programs. Member organizations include the American Board of Medical Specialties, American Hospital Association, American Medical Association, Association of American Medical Colleges, and the Council of Medical Specialty Societies. The ACGME accredits nearly 7,000 residency programs in 26 major specialty areas and 54 other specialized training areas. It is through this body that standards for training programs and procedures for accreditation are established.
biostatistics, epidemiology, health services management and administration and environmental health, in addition to coursework specific to occupational medicine and industrial hygiene. The last of the three years is a practicum in which the resident divides time between attendance at corporate occupational health services and the initiation and completion of a research project. The directors of the programmes in industry are certified specialists in occupational medicine, and, as preceptors, usually hold clinical academic appointments at the university offering the residency. The practicum represents supervised active participation in a comprehensive and organized on-site occupational health programme containing all the elements of contemporary preventive care at the worksite.

The university residencies normally have a clinical facility in the form of an Occupational Medicine Clinic, to which patients are referred and whose study is conducted as part of the practicum.

Nearly all of the residents who complete the programme take and pass the examinations given by the American Board of Preventive Medicine and, infrequently, a graduate will become certified in industrial hygiene in addition.

As in any graduate study in medicine, various modalities of instruction are utilized, including lectures, seminars, case conferences, clinic attendance, journal clubs, field visits, laboratory exercises, research projects, and specialty clinic rotations. Because of recent interest in one of the forms of instruction, specifically problem-based learning, it is fitting that the experience of one institution be related.

BACKGROUND

The Residency Program in Occupational Medicine of the University of California, Irvine was, at the time of the instructional element being described, placed in the Department of Community and Environmental Medicine, which more recently has become the Division of Occupational and Environmental Medicine in the Department of Medicine. The College of Medicine initiated its Residency in Occupational Medicine in 1976, and since has graduated each year physicians who were involved in meeting various desiderata in clinical medicine, laboratory and environmental measurement theory, and the core components of preventive medicine indicated earlier. The Center for Occupational and Environmental Medicine (COEH) is engaged not only in the residency program but has outreach to medical students and primary care residents, serves as a regional resource in its area of expertise, and carries out the other ventures of a university in research, community service, creative activity and scholarly publication. The topic being addressed here is the practical experience in solving problems presented by patients who were alleging work-related illness or some dysfunctional concomitant of recent or past occupational undertakings. It was to the Occupational Medicine Referral Clinic that patients were sent for evaluation by attorneys (usually for the defense and occasionally for the claimants), the state workers' compensation authority (Workers' Compensation Appeals Board), insurance underwriters, physicians in solo or group practice and, rarely, by an employer. Workers who had filed claims for compensation were evaluated; their attorneys, in concert with opposing counsel, had designated a specific faculty member as an Agreed Medical Examiner. The university was chosen for the resolution of the problem because the medicolegal community felt that an institution of higher learning would be free of bias in reaching a scientifically based conclusion, and would not be influenced by the possibility of great financial gain.

Irrespective of the physician to whom the referral was made, the 'case' would be assigned to a resident for study, which involved not only the usual development of both the medical and occupational histories, but the conduct of the physical examination, the request of pertinent clinical laboratory diagnostic procedures or instrumental measure of various physiologic functions. Subsequently, following the collection, authentication and interpretation of additional data, a review of literature germane to the alleged disease state and careful scrutiny by both fellow residents and faculty members of conclusions reached, the resident would prepare a final report.

THE ESSENCE OF THE EXERCISE

While the study of patients dates to the earliest days of medical skill acquisition through apprenticeship or the reading of medicine, a different process enters into the resolving of clinical issues in occupational medicine. By its very titular designation, the specialty is the only one of the many specialties uniquely designated by the certifying boards as interrelating work and health. Because of the system of workers' compensation that is universal in the employment area—where job-generated injury or illness entitles the worker to medical care and related fiscal benefits—most of the patients present with symptoms, claimed or real, or with objective findings that they associate with a work causation.

In the case of alleged occupational disease, where the clinical state can escape the immediate visibility of a wound, there most often follows contention as to etiology, and the distressed employee seeks redress through an attorney. This step is taken despite recognition or acceptance by the employer's workers' compensation unit, for the claimant feels that the award received has minimized the severity of his injury and its attendant wage loss. Once the process of litigation is entered, then months or years can pass with relative inaction. During this time span the worker, now a claimant and a patient, usually not gainfully employed, must retain his symptoms and remain inactive to give
Problem-solving

In recent years, considerable research has been conducted in an analysis of the process of problem solving as it is the pith of learning by medical students. Barrows has stressed the need for greater independent study and problem-based learning, pointing out that this mode is concerned not only with what knowledge is acquired, but how it is acquired. Further, the mechanism indicated is immediately applicable to occupational medicine: 'the integration of knowledge from the separate disciplines into an organized knowledge base useful in solving clinical problems'. In resolving questions of work causation, the resident draws on epidemiology, industrial hygiene, toxicology and clinical occupational medicine in establishing a conjoint information base.

In attempting a definition of 'problem', in the medical sense, Boshuizen and Claessen point out that the first main meaning refers to a patient's problem. Secondly, the problem can be that of the physician and involve a cognitive sorting of facts and fitting their interpretation into a substantiable conclusion. Finally, the problem might be the attorney's who is seeking a sound clinical footing for his stance in the litigation. In the discussion to follow, however, the problem will be that of the patient.

Some of the difficulties encountered in the solving of medical problems have been highlighted by Connelly and Johnson. There are such common confounding elements as the filtration of historic or perceived material through minds varying in their background of past experience. Or as Denham expressed it, the occasion and manner in which a patient relates his symptoms is modulated by a highly variable network of social sanctions and supports. Such subjective assertions are skewed further by language barriers, diminished intellectual capability, disorders of consciousness and of course, the fallibility of memory. Added to these influences is the biased solidifying of certain misperceptions held dear by the patient or the intermixing of truths and near truths, all to provide greater substance to the claim of job-causation of the health decrement and thus, greater financial return.

Various techniques have been used in the medical curriculum to develop the skill of problem-solving. Simulation has been employed, and role-playing by students and faculty and paid actors playing the parts of patients have been used to effect a sense of reality in the learning arena.

In opposition to the use of these artifices, though, is the involvement of the resident in real-life situations, with real patients, real attorneys and, in some instances, with the residents themselves serving as the real witnesses when deposed. In this mode of instruction, there is no need to insert or increase the clinical relevance because these cases from life are of clinical relevance.

Method

As indicated, a member of the faculty will have a patient referred who is nearly always a litigant or claimant (or in California, an applicant). Included with the letter of referral are as many of the pertinent medical documents as are available: hospital or physicians' office records, reports of physical examinations, laboratory test results and when germane, interrogatories, depositions and even police reports. The referral letter usually contains a set of questions requiring specific responses, most of which pertain to the alleged relationship between the work exposure(s) and the symptoms experienced or objective findings recorded.

Printed history forms are sent in advance to the...
The documents are reviewed by a nurse practitioner and the instrumented screenings are completed. The resident interviews the patient and fleshes out areas given significant positive responses. Particular attention, of course, is given the employment history for identification of work involving toxic contactants. A physical examination is conducted and, with a faculty member serving as a consultant—in the role of the 'attending' preceptor—the findings are reviewed and the history is rechecked. When indicated, interplaying psychosocial stressors or behavioural aspects of the illness are explored to demonstrate the indivisibility of disease states.

At this point, residents are on their own in their efforts to prove or disprove a cause-and-effect relationship between their patient's occupational experiences and their illness manifestations. Early in the two-year study period, the compilation of data derivable from several sources is challenging, if not difficult or threatening. Standards for exposure—through Threshold Limit values (TLVs), or Permissible Exposure Levels (PELs), criteria documents or Material Safety Data Sheets (MSDSs)—are new to them, as are environmental evaluations, inquiry of manufacturers of work materials and verification or substantiation of findings documented by previous examiners. Literature searches are initiated and careful reviews of previous research, case reports and epidemiological conclusions are undertaken.

When a preliminary model is thought to be ready, there is a case presentation before the other residents, faculty members and even visitors, if some are at the Centre that day. Through open discussion of the analytic process needed to reach an understanding of the pathophysiology involved in the worksite interplay of employee and the environment, the resident is suggested other, usually untouched, information sources. Included are corporate medical directors, researchers, unscanned periodic publications or even standard clinical or occupational medical texts. The teaching/learning in this period—termed tellingly by Brent as 'nascent physicianhood'—is carried on without humiliation, without deprecation and without the denigration described by Brent when he chidingly comments that, "Physicians who supervise residents should avoid treating lack of knowledge or skill in their supervisees as if it were a disease". Even though deadlines are established by the referring source persons, there is time for the development of a scientifically sound basis for the conclusions formulated.

Advantages accrue for the resident when the faculty comprises specialists with varying experience—research, epidemiology, pulmonology, in-plant practice, and the like. Special kinds of guidance can be given through these unique sources of knowledge so that the view is not that exclusively of academe but is tempered by years of real-world interaction with workers at risk.

Most important in this case development is the learning of the sources of established knowledge which are new to the resident whose professional honing of skills has been limited to hospital- or out-patient-based clinical medicine. He or she then explores the sources newly suggested to lend further substance to the case summation. In a subsequent case conference, the data are presented again, and if there is consensus as to the mechanisms present in the patient's work intoxication, the material is then ready for preparation of a formal report. The histories, the physical examination findings, the environmental measurements and the decisions of previous evaluators are documented, to be followed by a discussion or substantiation of the conclusions presented, including responses to the questions proferred by the referring source. References are given to lend credence to the citations of the work of others.

After correction of the draft by the Resident-writer, the report is reviewed by a faculty member to assure several objectives: that the report is of university quality, that the resultant material is scientifically solid and representative of good deductive reasoning, that the grammar and syntax are impeccable and that, were the document to be entered as evidence in a court of law, it would withstand the scrutiny of all counsel and of the presiding jurist.

Following final corrections, copies of these lengthy documents are forwarded to the referring individual or institution and to the patient. On rare occasions, requests for further clarification may be made by the concerned attorney.

**THE PROCESS**

Success, as pointed out by some sages, is not the attainment of a goal but is the passage on the way to the goal. In the same sense, it may be unimportant if the patient has interstitial fibrosis consistent with exposure to respirable free asbestos fiber. What is of true worth is the resident's clear understanding of how the decision was derived that the pathologic changes of the lung did result from a work exposure of a certain magnitude and that no other contact would have produced the same functional impairment or physiologic deficit. It is the development of the case in a rational and provable manner, insofar as possible in light of contemporary technology, that makes the conclusions defensible and that allows for the greatest potential in learning.

Of particular worth in the learning process is the identification of the clues used to establish etiologic relationships. Special attention to temporal elements is needed: did the exposure occur in such a timely fashion as to result in the pathologic changes encountered? In fact, was there an exposure of any significance, and was it of such magnitude as to be disease-causative? These questions represent, in part, the extrapolation of the body of theory offered in the epidemiology and toxicology classrooms to the practicum of case resolution. The centrality of concern is
with the development of the dose-response relationship if in fact, one does exist.

The sense of professional satisfaction or, to cite Brent once more, the 'sense of professional identity', comes from the total study of the patient and not from the legal or judicial outcome of the hearing or trial. Many cases or suits are settled by counsel for the process is less costly than were the issue to go to court, proceeded through the appeal process and possibly even go to a higher judicial level. While winning a case is of significance to the attorney, the outcome is not important to the resident or the attending faculty member because of familiarity with some of the capriciousness of certain administrative bodies. The ultimate decision is made so frequently by a lay jurist who faces two medical reports of opposing opinion and then must decide which body of evidence is the more supportive of the argument offered. Interestingly, rarely does the referring attorney voluntarily report the final decision to the Centre for, somehow, the intellectual interest of the resident and the faculty is not perceived by the attorney.

With time, the utilization of resources becomes easier for the resident, and he or she becomes accustomed to ready communication with any knowledgeable official, researcher, environmentalist, author or client representative. Most difficult to understand, though, is that legal definitions and medical definitions most often are polar, or certainly different and this discrepant matching is one of the most valued products of the learning process. What is important is that the resident recognize the difference and accept the mode of thought of the courts.

Stemming also from the development of a case report is the care needed in the selection of language in order to avoid misinterpretation. For example, the slightest attribution of symptoms or findings to an occupational etiology may, in legal eyes, cause the alleged illness to be work-associated in its entirety. The appropriate use of such terms as 'possible' and 'probable', or such phrases as 'in my opinion' or 'in my experience' is given scrutiny in the case reviews. As voiced by one resident, 'every word must be considered'.

COMMENTS

The value inherent in the resident's study of cases from the contentious world of reality is to learn of the persuasive influences exerted on physicians by the sources requesting examinations of their clients. Early in the residency, it becomes axiomatic that a report from Dr. X will proclaim an unquestioned job relationship to the clinical findings or alleged symptoms, while a review by Dr. Y will invariably favour the defendant. Working in the university setting, the resident realizes that bias cannot enter into a scientific analysis, and that in this setting the examining physician is not an advocate. A sound study, that results in logically structured conclusions, based on a thoughtful dissection and later assemblage of data is the base of credibility—a credibility produced by the appropriate inferences from sometimes imprecise data.

In popular language, one calls them as one sees them, and the ultimate opinion may agree with the stance of the defending attorney or it may be contrary to his wishes. The good lawyer, however, appreciates scientific honesty for it assists in the final understanding and handling of the case, even if it results in settlement.

Further, a reading of depositions gives insight into courtroom behaviour and the varying directions taken by attorneys on direct or cross examination in their effort to obtain responses favourable to their arguments. Even in those cases where a review and an opinion are requested, without examination of the client, there is much to be learned from the perusal of a deposition regarding the personality, intelligence, socio-economic status, technical knowledge and objectives of the patient in his pursuit of monetary recompense.

A review of the responses to an interrogatory provides understanding of much of the industrial processes and technical aspects involved in the case.

THE ESSENCE OF PROBLEM-BASED LEARNING

While not utilized extensively in contemporary medical education, problem-based learning, as described succinctly by Gardner, was initiated at McMaster University in Hamilton, Ontario, Canada. It forbids lectures and other forms of formal instruction. The objective is to force the students 'to find out for themselves'. In that system, students were divided into small groups of four or five and different groups were used for different problems so that an individual was not always working with the same group. A problem would be given, and then the students, in medical school, would have to search out the areas of medical knowledge suggested by the case history and arrive at a differential diagnosis and possibly a diagnosis. The information would not be forthcoming through the usual modality of a lecture or a seminar, but would have to be obtain through reading, viewing videos, visiting pertinent clinical or preclinical science departments and the like.

At the end of a 4 or 5 week period, the students present their views to an instructor who listens carefully, asks questions, and tries not to give answers. As Gardner puts it, 'Here is participative self-motivated learning carried to the end of the road'. McMaster graduates did as well on their Canada-wide medical examinations as those graduates from other schools, but seemed to seek a greater number of research-oriented positions. "[T]he course appears to produce an attitude of curiosity and of wanting to know in addition to inculcating the idea that learning is about finding out, and that finding out is up to the individual."13

There have been allusions made to this method of learning. In a study of educational programmes in
USA medical schools scheduled carried out through use of the Annual Medical School Questionnaire [sent to the deans of 126 schools accredited by the 1992–1993 Liaison Committee on Medical Education (LCME)], one item asked how schools made use of different instructional formats, problem-based learning being one. The response indicated that this modality was used as "a minor part of one or several courses in 46 schools, as a major part of one or several courses in 37 schools, as a major part in many courses or a curricular track/segment in 26 schools, and not used in 16 schools (one school did not respond)". The query concerning active student learning was included because of a growing call to decrease the number of didactic lectures, in favour of other teaching formats.

While not touching problem-based learning directly, Guidotti in an all-inclusive list of 'Learning Objectives in Occupational Medicine', pointed up 15 cognitive skills which "Given a realistic scenario, the physician will be able to perform [all] to an acceptable standard". The skills, as evidence of learning, can readily be the abilities acquired by a student who has been self-taught through the problem-based school of gaining knowledge.

The words of a seasoned educator, used in describing a training format, are applicable to, and give the sense of problem-based learning: "These posts are not to be observational. They must give experience in making decisions and taking responsibility". In an effort to integrate occupational health into a medicine clerkship through use of problem-based learning, investigators found that such use of the modality, with "specific occupational content [was] well accepted by students and modestly improve[d] their occupational history taking." In another suggested scheme to insert instruction concerning occupational medicine into the internal medicine residency, Cullen and Rosenstock listed these expectations as resulting from a 4–6-week rotation in an occupational and environmental medicine service—they are given for they parallel the expectations derivable from the problem-based learning mode described initially: to learn (1) basic principles of diagnosis and management of occupational or environmental illness; (2) how to parlay historic information from the patient into objective exposure information; (3) how to utilize existing books and databases to approach occupational/environmental illness; (4) how to look at a workplace and approach the issue of primary prevention; and (5) how psychosocial and medicolegal aspects of work have an impact on the worker-patient and affect functioning in health and disease.

At McMaster University itself the problem-based, self-directed method of learning has been used in a post-professional diploma course in occupational health and safety, having been adopted from McMaster's undergraduate programme in Medicine. Because of the nature of occupational health practice—multidisciplinary—the student teams represented the different specialties needed to deliver occupational health services. The primary objective was to develop skills that would enable the student to become a life-long learner rather than imparting only content which quickly becomes outdated. Evaluation of the course revealed that a majority would choose the McMaster diploma in place of a three-month lecture course.

In short, the utilization of problem-based learning can be as productive—if not more so—than the age-fringed formats currently in use, insofar as applicable to postgraduate education in occupational medicine.

A working model is presented in a case-conference format to fellow residents and faculty members where guidance is offered, erroneous decisions are altered or new sources of needed information are suggested. When all contributing quanta of knowledge are integrated into the case study, a second presentation is made for final honing of the summation and conclusions composing the report to the referring attorney or agency.

On completion of the first draft, the document is reviewed by the attending faculty member, not only for scientific and clinical accuracy, but for quality of writing and discussion, to assure professional reporting that meets university standards of excellence.

The essence of the learning process is not solely the configuration of a diagnosis, but the understanding of the pathophysiological mechanisms involved in the resultant symptom constellation or findings.

**CONCLUSIONS**

The utilization and study of real patients referred by attorneys or public agencies provides clinical and legal relevance to problems of true industrial intoxication or alleged occupational illness.

In the effort of identifying a work causation of a set of symptoms or assembly of clinical findings, the resident resolves the problem through application of knowledge sources new to the young physician. The resultant report to the referring source must be scientifically based and totally defensible in a court of law, where it usually is subject to both discovery and entry as evidence. Learning is given true substance when dealing with the reality of the patients, the workers' compensation system, the adversarial nature of hearings and trials, the legal idiom and the need for exactitude in language that may influence the remainder of an individual's life.

The resolution of problems derived from the world of reality surpasses any mode of simulation in the learning process.

**SUMMARY**

In the residency programme based in the Occupational and Environmental Health Centre of a university, the residents are assigned patients for study who are clients referred to faculty members for determination of the
work-relatedness of their alleged illness. The cases are neither hypothetical nor contrived and present real clinical and legal significance. While the reviews required early in the 2-year period present difficulty to the young physicians accustomed to hospital or outpatient medical practice, they soon learn that different sources of information must be sought to assist in determining the association with work if, in fact, one does exist.

The learning process is characterized by the utilization of data derived from such disparate individuals or institutions as manufacturers and their medical or industrial hygiene personnel, public agencies, data banks, MSDSs, TLVs or PELs, physicians, the courts and attorneys. When coupled with the results of a review of the patient's medical and occupational histories and results of physical examination, the resident gradually formulates the resolution of the problem which has become a medicolegal issue.

REFERENCES

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