Special Report

Occupational Medicine

A New Focus for General Internal Medicine

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• **In the past two decades, occupational medicine has advanced from a formerly clinical discipline to one focused on epidemiology and toxicology. However, because efforts to prevent occupational disease by concerted application of industrial hygiene have not eliminated the problem, there remains a strong need for clinical interventions. Appropriate interventions could result in a further substantial reduction in the morbidity and mortality of work-connected illness. Unfortunately, neither adequate training nor the necessary scientific foundation for clinical decision making presently exist. Studies are needed to characterize the modern spectra and natural histories of virtually all recognized occupational diseases and to evaluate the efficacy of available therapeutic strategies. Sections of general internal medicine potentially offer an ideal academic setting to address these educational and scientific deficiencies.**

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In early 1979, lured by the challenge of social urgency and curiosity about a field discussed so widely in the press and so rarely in the hospital, several of us established a clinically oriented program in occupational medicine in our burgeoning Section of General Internal Medicine at Yale University School of Medicine, New Haven, Conn. Initially, our aim was to assess what role clinicians and clinical investigators might play in the effort to control occupational disease, widely touted as an unrecognized "epidemic."[1-3] More globally, we hoped to explore the potential for development of a formal discipline in clinical occupational medicine which, perhaps surprisingly, did not exist in the United States only five years ago.[4]

Three broad themes that emerged from our experience are the subject of this communication. First, simply, is that there is, indeed, a pressing and enduring role for clinical occupational medicine as part of the multidisciplinary approach to limit occupational disease. As a corollary to this, there is a dire need for clinical research in the field if that role is to be adequately addressed. Finally, given the scope of these agendas and the present structure of academic medicine, sections of general medicine in departments of internal medicine may provide an ideal and heretofore underrecognized base for clinical occupational medicine to grow and flourish.

HISTORY OF OCCUPATIONAL MEDICINE IN THE UNITED STATES

Although there have been several recent reviews of the history of occupational health in this country,[1,5,6] none have addressed the strange fate of the clinical science. Certain aspects can, however, be surmised from the writings of the great American pioneers in the field, such as Alice Hamilton and Harriet Hardy, and observation of serial changes in the scientific literature. It is evident that intensive clinical investigations were conducted and reported commencing in the second decade of this century. By 1925, an authoritative clinical text[7] appeared combining state-of-the-art clinical observations with specialized consideration of industrial hygiene and preventive medicine principles. By the 1950s, there was an abundant literature, including clinical studies of hundreds of occupational diseases. Several journals were devoted almost exclusively to such observations.

The last two decades, however, have witnessed a significant change in the direction of occupational health. The successes of epidemiologists at demonstrating some occupational causes of prevalent diseases utilizing available vital statistics as data bases ushered in a new and powerful strategy for the study of the health effects of work. Advances in toxicology offered the prospect for rapid and accurate predictions of human health effects. In addition, increasing pressures for specialization within the medical community and compartmentalization of resources rendered less practicable the historic role of generalist-clinician and field scientist.

Ironically, a major blow to the clinical tradition resulted from the massive federal effort to regulate workplace exposures and upgrade the level and quality of professional training and research signaled by the Occupational Safety and Health Act of 1970. By law, evaluation of health conditions in the nation's factories, shops, and offices was to be determined not primarily by physicians but by industrial hygienists; clinical evaluation was relegated to an ancillary role in the control of a handful of toxins. To meet the congressional mandate, the National Institute for Occupational Safety and Health (NIOSH) was established as a federal research and training institute. The need to establish data on which to recommend (industrial hygiene)

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standards translated into the development of intramural and extramural capacities in toxicology and epidemiology. Within industry, medical and safety departments turned to the task of meeting the new regulations; those corporations with sufficient resources and interest joined the efforts in epidemiology and toxicology. Although new postgraduate training programs for physicians were introduced in the schools of public health and departments of environmental science supported by NIOSH, these focused on the study of industrial hygiene, biostatistics, epidemiology, toxicology, and health administration[8]; specialized clinical courses were of limited scope and occupational medicine practice experience often not available. At most medical schools, neither postgraduate nor undergraduate training in occupational medicine existed at all.[9]

ROLE OF OCCUPATIONAL MEDICINE IN OCCUPATIONAL HEALTH

Experience, however, has led us to believe that a serious role exists for clinicians in the areas of disease recognition, treatment, and prevention. This conclusion stems from the following observations:

1. *Millions of Americans have already been exposed to hazardous substances sufficient to alter the expected length and/or quality of their lives. For some hazards, data suggest that means of altering outcome may be available.* For example, among some 20 million living men and women with a history of occupational asbestos exposure, approximately 75,000 to 300,000 excess malignancies are anticipated in the next 50 years.[10,11] Although attempts at secondary prevention by intensive screening have not been fruitful,[12] data suggest that the toll from lung cancer, the major risk, could be reduced substantially by directed efforts at smoking reduction.[13] Further, this group would seem to provide a unique opportunity to study the effectiveness of cancer chemoprevention, for example with vitamin A metabolites.[14]

2. *Many workers continue to be exposed to environments that cause clinical disease and enhance risk of long-term impairment; interventions can reduce morbidity.* The regulatory process has lapsed far behind the available data base so that some recognized hazards are not controlled or are inadequately so. Further, technical, economic, and motivational factors have resulted in widespread violations of existing standards. A pertinent example is lead, which remains uncontrolled in large portions of the primary and secondary smelting and storage battery industry as well as in nonferrous foundries, iron working, and other trades. Despite the unusual provisions in the lead standard calling for regular blood testing and removal when levels are elevated (this provision is the only one promulgated by the Occupational Health and Safety Administration that requires specific administrative controls based on results of biologic tests), clinical poisoning still occurs commonly.[15] Although hardly an alternative to primary prevention, preliminary data demonstrate that chelation and/or removal from exposure alters the outcome of the disease.[15]

3. *Introduction of new substances into the workplace poses an ongoing source of new disease.* Despite the requirements of the Toxic Substances Control Act of 1976, new chemicals appear on the commercial market at a rate of thousands per year and data predictive of subacute or long-term effects in humans, comparable with the data available on new drugs, is usually lacking. In this setting, both diligent surveillance of newly exposed groups and expectant clinical recognition play crucial roles in identifying bad actors for early control.

An example of this role was demonstrated by the recent discovery of the neurotoxin dimethylaminopropionitrile. Although congeners had proved neurotoxic in animal studies, this agent was introduced commercially in the middle 1970s as an accelerator for polyurethane manufacture. Two years later, many workers had neurogenic bladders; several had sacral neuropathies as well. Fortunately, several patients were treated in institutions with clinical occupational medicine expertise whose participation resulted in a rapid determination of the scope and basis of the problem and removal of dimethylaminopropionitrile from the market, although not before dozens of cases, many irreversible, had occurred.[16]

4. *Idiosyncracy and host variability result in inevitable disease occurrence despite rigorous environmental control.* A substantial proportion of occupational disease represents true hypersensitivity or other "atypical" responses to substances in the workplace environment, especially dermatoses, reactions of the upper and lower respiratory tract, and neurointoxications. By definition, the attack rate in a given workforce is relatively low, which often obscures the relationship between the disease and work and to some extent limits the effectiveness of further environmental manipulation in disease control. Correct diagnosis and management are especially important in this group, since the consequences of unrecognized disease may be severe, as increasingly reported in patients with occupational asthma, for example.[17]

5. *Clinical observations can form a strong basis for change in industrial practice and may provide the foundation for epidemiologic and toxicologic investigations.* For example, we were recently asked to evaluate the cause of a fatal blood dyscrasia in a printer. Recognition of high exposures to several glycol ethers recently implicated as marrow toxins in animal studies,[18] and proof that co-workers were affected resulted in prompt, voluntary substitution with safer materials.[19] More importantly perhaps, these findings have stimulated accelerated toxicologic study of the whole class of these widely used solvents by industry in the search for nonmarrow toxic congeners.[20,21]

Of course, these observations are not meant to deny the obvious and enormous importance of industrial hygiene control of toxins or epidemiologic and toxicologic study of their effects. On the contrary, it is only in the context of these ongoing activities that a role for clinical occupational medicine can be claimed. But the clinical role, too, is enormous and important. Expressed another way, it is only with establishment of a strong clinical complement to the other disciplines that we may even approach the congressional goal to "assure insofar as practicable that no employee will suffer diminished health, functional capacity or life expectancy as a result of his work experience"[22] within the constraints presently shaping industrial and regulatory policy.

OBSTACLES TO ADVANCEMENT OF OCCUPATIONAL MEDICINE

Although it has been convincingly demonstrated that the present care available to working people, including both company based services and the mainstream health care system, is inadequate to the proposed tasks,[1] the basis for this shortcoming has been only partially analyzed. Most have perceived the problem primarily as one of deficiency of medical education.[2,23] Inability to recognize symptoms and signs of illness as related to work exposures precludes useful clinical intervention; opportunity for disease modification and possible prevention of disease in others is simply lost. Yet fewer than one third of all undergraduate medical curricula include any required coursework in oc-

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cupational medicine[9] and virtually no postgraduate training is included in specialty training for internal medicine or family practice. Students and house staff have virtually no contact with practitioners or investigators in the field.

Equally important as a cause of the inadequacy of clinical occupational medicine, however, is the absence of a suitable scientific foundation for clinical decision making. For all but a relatively small number of well-characterized occupational disorders, primarily the lung diseases, few new clinical observations have been added to those of the last generation. Although the clinical appearance of historically recognized conditions has been modified by changes in industrial practice and medical technology, modern clinical descriptions are lacking. Further, studies of diagnostic strategies, prognostic indicators, and the efficacy of available modalities for management are largely nonexistent. Virtually every patient referred to us inevitably challenges the limits of available knowledge no matter how widespread or ancient the cause of his or her problem. For example, consider the following questions raised almost daily in our practice. When should patients with high body lead burdens be removed from lead or chelated? When, if ever, should they be allowed to resume exposure to lead? What factors presage progression of early asbestosis? How might such progression be modified? Data relevant to these obvious questions, crucial to rational care of patients with these prevalent conditions, remains unassembled or unanalyzed. Yet, without such data, clinical occupational medicine must remain an art, largely confined to the unenviable task of documenting the predictions of our colleagues in epidemiology and toxicology.

A final obstacle to the development and implementation of an effective approach to clinical occupational medicine is the social, economic, and political "overlay" that inevitably complicates practice. The vagaries of the compensation system, notoriously unresponsive to occupational disease cases,[24] the financial impact to patient and employer of otherwise straightforward therapeutic decisions, the often adversarial relations engendered between employees and their employers, and the diverse mixtures of responsibility between a worker's private physicians and company medical services all must be recognized and coped with by any venturing into this field. At a minimum, these factors frustrate the attempt to practice rationally and substantially limit the possibilities for clinical research—the real world is not readily "controlled." Although some cynics are convinced that these hurdles are insurmountable, progress is nonetheless possible within these constraints. Turned another way, perhaps only by the persistence and input of clinicians and clinical scientists can some of these societal complexities be changed.

RESEARCH AGENDA FOR CLINICAL OCCUPATIONAL MEDICINE

Whereas providing the resources for remedying present educational deficiencies and modifying the organization of medical services and benefits available to workers require large social decisions beyond our immediate control, the development of the clinically necessary data-base does not. Clinical epidemiologic methods, successfully applied to a wide range of clinical issues during the past two decades, are readily applicable to occupational medicine, and large, identifiable populations are potentially available for study. The diversity of opportunities for productive and original work in this field is enormous. Not only are there numerous types of hazards and work settings, each with its own pattern of organ system effects that need to be delineated, but there are also several levels of investigation requisite to provide the foundation needed for scientific practice.

To illustrate this latter point and further define the scope of the agenda at hand, I propose the following broad classification of research priorities with examples from our incipient efforts and those of other investigators.

1. *Defining the spectrum of symptoms, signs, and laboratory findings in patients with specific occupational diseases as they appear in clinical settings.* For example, we recently undertook a detailed retrospective review of all patients referred to us for lead poisoning. Surprising to many, colic and anemia, which dominated the clinical picture in Alice Hamilton's time, were confined to a small subset of our patients with brief, intense exposure, whereas the majority with longer exposures had vague neuropsychiatric and muskuloskeletal disorders.[16] Another unexpected finding was the previously undescribed prevalence of endocrine abnormalities, investigated as part of a thorough effort to explain the patients' symptoms and signs.[16,25,26] It has become apparent that available descriptions of many conditions have been heavily weighted by their most conspicuous (but not necessarily most important) features while many aspects, often more readily apparent on laboratory testing than on physical examinations, have been overlooked. There is thus a need to redefine many of the "classics," as well as to define newer entities. Often this requires no more than diligent clinical observation of an appropriately representative series of patients. Despite their obvious scientific limitations, even case reports illustrating unusual or unrecognized features can be of clinical value given the present state of the art.

2. *Characterizing the "natural" and modified histories of occupational disease.* Having characterized the spectrum of a disease, the next challenge is to define the longitudinal history of the process. Of course, these observations can be neither randomized nor controlled, since the decision to expose cannot be the investigator's. Furthermore, ethical considerations demand conservative interventions whenever adverse effects are apparent. Nonetheless, careful comparison of historic "controls" and longitudinal observations of treated subjects can provide considerable useful information. An example of this type of work is the studies of Chan-Yeung and colleagues[17] characterizing the natural history of occupational asthma from western red cedar dust exposure. Contrary to traditional dogma, Chan-Yeung et al noted that a large portion of patients did not have a remission on removal from exposure to the causal agent.[17] Furthermore, although duration and intensity of exposure increased the risk of acquiring asthma, the length of continued exposure after onset of symptoms was a clear predictor of bad outcome; those promptly removed tended to improve quickly.[17] Combined with comparable studies of asthma in other industries, these data are precisely the kind necessary to provide a rational basis for clinical practice.

3. *Comparisons of alternative strategies for diagnosis and treatment.* Once the clinical spectrum of disease and natural history are unraveled, the utility of particular diagnostic tests and interventions must be compared. Although methods again must be adapted to the nonrandom and often uncontrollable realities of the clinical setting, considerable information is obtainable. For example, we have recently undertaken retrospective review of patients with a posttraumatic or "postoccupational disease" stress disorder, a relatively common disorder in occupational medicine practice.[27] While this has traditionally been recognized only by exclusion after exhaustive search for organic causes of symptoms, our review has demonstrated clusters

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need to incorporate the principles of occupational health into their repertoire. Where else shall broad awareness of the role of the workplace in health be merged into widespread clinical teaching and practice? Within the medical center, awareness of this interest may prompt referrals of patients with proved or suspected occupational illness, enhancing practice and teaching and affording opportunities for in-field "clinical epidemiology."

For research, the diseases of work offer unparalleled opportunity for studies in clinical recognition, management, and prevention. While the social, financial, and ethical considerations confer new challenges to the investigator, these are all the more reason to attract clinical scientists with the most acute appreciation of available study designs and methods. Few more prevalent and urgent problems await solution.

What began, perhaps, as a marriage of convenience now offers the promise of a bountiful and productive future. We offer it as a model to our colleagues in general internal medicine and to those in our society with the power and resources to control occupational disease.

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