External Practicum-Year Residency Training in Occupational and Environmental Medicine: The University of Pennsylvania Medical Center Program

Edward A. Emmett, MD, MS
Judith Green-McKenzie, MD, MPH

We describe a competency-based training program that allows physicians employed full-time in occupational and environmental medicine to satisfy the supervised practicum year of training required by the American Board of Preventive Medicine (ABPM). The program is designed for trainees with greater clinical experience than the 1 clinical year required by the ABPM. To date, 25 physicians from clinic-based, academic, corporate, and government employment across most geographic regions of the United States have been admitted into the program. Most completed a master's in public health (MPH) in a distance-learning, on-job, on-campus, or executive program. The practicum-year training has been highly successful, as evidenced by improvements in resident self-assessment of competency, resident satisfaction with the training, faculty evaluation of resident performance, and success rate in the ABPM examination. The program has opened a new pathway for physicians making a mid-career shift to occupational and environmental medicine to obtain high-quality, in-depth education and board certification. (J Occup Environ Med. *2001;43:501–511*)

From the Hospital of the University of Pennsylvania, Department of Occupational Medicine.
Address correspondence to: Dr Edward A. Emmett, Hospital of the University of Pennsylvania, Department of Occupational Medicine, GR Silverstein, 3400 Spruce Street, Philadelphia, PA 19104.

This article describes the External Practicum Year Residency Training Program in Occupational and Environmental Medicine (UPenn-RES) developed in Philadelphia. The program was commenced at the Thomas Jefferson University Hospital in 1997. In July 1999, the program was moved in its entirety to its present location at the University of Pennsylvania Medical Center and the Medical School of the University of Pennsylvania.

The UPenn-RES program aims to provide high-quality training to satisfy the supervised practicum-year requirement for residents desiring to take the certification examination of the American Board of Preventive Medicine (ABPM). The program does not provide training for the other 2 years required by the ABPM, namely, an accredited year of clinical training and a postgraduate year of academic training. It is designed for physicians who are already employed full-time in the practice of occupational and environmental medicine (OEM) and thus is particularly appropriate for physicians making a mid-career shift into occupational medicine. UPenn-RES is based on the principles of adult learning and of building on an existing professional skill base to establish a comprehensive set of desired competencies. The resources, opportunities, and caseload at the resident's place of employment are used as the vehicle for learning, supple-

mented as necessary by additional experiences. The program is designed to enhance and develop mentoring and networking arrangements, both at the site of employment and through the training program, to provide for personal growth and career development.

UPenn-RES is an innovative program, designed from the ground up to achieve these objectives and unconstrained by the need to incorporate elements of an existing training program, which allowed for an unusual degree of flexibility and innovation. To date, 25 trainees have entered the program, which is now in its fourth year. As of December 2000, there were eight trainees in the class of June 2001.

Rationale for an External Supervised Practicum-Year Training Program

Since at least the mid-1960s, entry into the advanced practice of OEM has been characterized by two different career paths, traditional residency and mid-career shift.

Those entering the specialty through residency training generally became interested in OEM in medical school, undergraduate college, or during another residency program (typically, internal medicine, an internal medicine subspecialty, or family practice). Either after an initial clinical residency year or in combination with internal medicine or family practice, the residents have typically completed the academic and practicum years required by the ABPM at the same institution. This training has been supported by various means, including National Institute for Occupational Safety and Health (NIOSH) grants, the military, Occupational Physicians Scholarship Fund scholarships in latter years, and, to a quite limited extent, by hospital or university funds. This career path has almost obligatorily been for those going into academic research positions and for many government agency posts, and it has been desirable for many corporate positions, especially for those focused on toxicology or policy matters. A number of individuals with this type of training have risen to the most senior positions in the profession and in multinational corporations.

The strengths of physicians trained through this career path have included formal training in the academic, preventive, research, and regulatory aspects of OEM. In our experience the relative weaknesses, at least in the initial years of specialty practice, have typically been in the area of maturity of clinical judgment regarding complex medical and social issues. This type of judgment usually comes from varied clinical experiences gathered over an extended period of time.

Those choosing the specialty at mid-career typically have had a number of years of medical experience (often in internal medicine, family practice, or emergency medicine) before beginning to work part-time in the specialty and discovering their enjoyment and penchant for the practice of occupational medicine. Many of these physicians have pursued no formal training other than a limited number of entry-level continuing medical education (CME) courses (such as ACOEM's basic curriculum). Those who took corporate jobs (which were plentiful in the 1970s and 1980s) were trained on-the-job or through mini-residencies that offered more extensive training. Because of the limited scope of activities in many corporations and in many occupational medicine clinic settings, on-the-job training and experience can be quite narrow in scope. Traditional residency training was seldom an attractive option for mid-career shift physicians, not only for reasons of cost and logistics, but also because the style and content of the training was not always appropriate to the trainee's level of medical maturity.

Physicians pursuing a mid-career change have been attractive to many corporate employers, to freestanding occupational health clinics, and to some hospital-based clinics, particularly those outside of academic medical centers. The strengths of these physicians have been in their clinical judgment, broad medical experience, and medical maturity, whereas their relative weaknesses have been in the academic, preventive, research/scientific, and regulatory aspects of OEM. Just as with the traditional residency training career path, a number of individuals making a mid-career shift to occupational medicine have risen to the most senior positions in the profession, including those in multinational corporations. In contrast to most medical specialties, occupational medicine physicians who graduated from medical school before 1984 are able to sit for the ABPM certification examination through a "grandfathering" option,[1] so the demand for residency training is relatively limited among experienced physicians making a mid-career switch to this field. Although their pass rate on the ABPM examination was lower than that for residency-trained physicians, this option allowed many physicians making a mid-career shift to become diplomates of the ABPM. This option is no longer available to those who graduated after January 1984.[2]

Both entry tracks have brought physicians with many of the skills required for the broad practice of OEM, but, generally, neither track has included all the requisite competencies without further development. As a result, there has been a market need for physicians from both types of career paths.

The past several years have seen developments in educational technology, particularly in distance learning and in the adoption of a competency-based learning paradigm. These offer substantial new possibilities to enhance the training and skill development of those wishing to enter OEM through either path. Application of a competency paradigm for training allows the

training and professional development needs of both traditional residency-trained and mid–career-shift physicians to be evaluated against the same set of outcome requirements, even though their initial skill base may be very different. Training is then directed at achieving a common set of competencies by the end of the training experience. Distance-learning techniques, made possible by advances in information and communication technology, allow academic and didactic material to be learned off-campus at a time and place chosen by the student. The trainee can be freed from the constraints of time and location that previously have restricted academic education. Executive type (or "on-job, on-campus") master's degree programs have also been developed that require a series of 2- to 5-day periods of attendance on campus, distributed over 2 or more years. Distance-learning and on-job, on-campus programs have given much greater access to the ABPM-required academic year MPH or equivalent training for physicians in practice who wish to make a mid-career shift to specialist OEM practice.

Using competency based training and on-job, on-campus techniques, we were able to establish a successful competency-based external residency program that satisfies the supervised practicum-year training requirements of the ABPM and is accredited by the Accreditation Council for Graduate Medical Education (ACGME). Traditionally, practicum-year residents have been employed by the training program, although for at least 4 months, they were assigned to work in industry in what is described as "the real world of work."[3] UPenn-RES makes use of the workplaces in which a physician already works to provide the training experiences.

Admission Requirements and Characteristics of Trainees

All residents admitted into UPenn-RES must have completed at least 1 year of accredited clinical training. In practice, all residents have had substantially more than 1 year of clinical training and/or experience, and it is doubtful whether an individual with only 1 year of clinical experience could gain acceptance to the program. Many residents admitted to the program have already been certified by one of the boards approved by the American Board of Medical Specialties and/or have additional relevant education. The 25 incoming trainees include 11 diplomats of the American Board of Internal Medicine, 3 of the American Board of Family Practice, and 1 diplomat each of the American Boards of Emergency Medicine and Family Practice. Additional qualifications have included one fellowship each in infectious disease and sports medicine, and a doctorate, master's, and two engineering degrees.

Residents must also have competed, or made significant progress toward completing, an MPH or equivalent degree. Significant progress means completion of at least the four core courses required by the ABPM (Biostatistics, Epidemiology, Environmental and Occupational Health, Health Services Organization and Administration) and course work on the social and behavioral influences on health. Among the 25 incoming residents, 19 obtained their MPH or equivalent degree in a distance-learning, an on-job on-campus, or an executive-release program (Medical College of Wisconsin, 16; University of Michigan, 2; Columbia University, 1), and 6 obtained their degree in a residential program (MHSc University of Colorado, 2; MPH Johns Hopkins University, MBA University of Pennsylvania, MPH University of North Carolina, and MPH University of Pittsburgh, 1 each). To date, each class has had residents from several institutions. The heterogeneity of academic year experience among a resident class has been a strength that has augmented the diversity of prior experience and knowledge in the group.

TABLE 1
Selected Site Characteristics Considered in Determining Suitability as a Training Location

- Number of employees and variety of jobs and job settings.
- Medical facilities, clinical and information resources
- Caseloads
- Type of patients seen
- Opportunities for collaboration with industrial hygienists, nurses, safety personnel, counselors, and/or others concerned with psychosocial issues. Opportunities to deal with clinical, scientific, social, legal, and administrative issues.
- Opportunities to deal with issues from the perspectives of workers and their representatives, of regulatory or legal authorities, and of the employers.
- Opportunities to interact with workers, human resources personnel, industrial relations personnel, line supervisors, worker representatives, and the outside medical community.
- Opportunities for experience in the clinical and administrative aspects of direct worker care and job assignment, medical screening and surveillance, health conservation and promotion, environmental assessment, employee assistance, and relevant regulatory compliance.

The site where the resident is employed must be willing and able to provide the range of experiences required for a meaningful training year. There must also be adequate supervision by a highly qualified individual at the site who can supervise and evaluate the day-to-day work of the resident. Management at the residents' site must be willing to accommodate the time and effort requirements for the resident to attend sessions in Philadelphia and to facilitate the projects required from each resident (see later). Signed affiliation agreements spell out the site requirements in detail. The adequacy of a proposed training site is evaluated before admission of the resident to UPenn-RES. Items evaluated are summarized in Table 1.

The curriculum vitae of the proposed supervisor at the site is also reviewed. Quite often the prospective resident is the director of the OEM program at a particular location, or even of an entire organization. In such cases the supervisor may be someone such as a vice president for medical affairs, a department chair, or other responsible individual. As necessary, innovative arrangements have been made to coopt additional local supervisors and resource persons in preventive/occupational and environmental medicine to ensure adequate local supervision.

The program is national in scope, and almost all regions of the continental United States have been represented. Of the 25 incoming residents, 3 were from the Northeast (New York–2, Connecticut–1), 11 from the Mid-Atlantic (Pennsylvania–5, New Jersey–2, Maryland–1, Delaware–2, Virginia–1), 5 from the Midwest (Ohio–3, Illinois–1, Kansas–1), 4 from the Mountain States (Colorado–4), and 1 each from the Southeast (Alabama–1) and the West Coast (California–1).

Although most of the residents are employed in the full-time clinical practice of OEM in a hospital (5) or freestanding (11) clinic, approximately one-third are in corporate (5), governmental (1), or academic (3) employment. The distribution of types of employment sites broadly reflects the employment distribution of specialist physicians in OEM at this time.

Competency Objectives and Educational Plans

The training program is competency-based. The competency objectives adopted for UPenn-RES were developed uniquely for the program, with substantial input from program faculty and members of the Residency Advisory Committee. The objectives were designed to incorporate the list of program requirements for Residency Education in Preventive Medicine for Occupational Medicine[3] and for the ABPM.[4] They were developed with careful reference to the American College of Occupational and Environmental Medicine Competencies.[5] The competencies are arranged in six subject groupings, as shown in Table 2. The first grouping incorporates a number of general competencies. The remaining five groupings form the subject matter for the five specific modules around which much of the program is organized. A full listing of the competency objectives for UPenn-RES program graduates is given in Table 3. The desired competency profile, and we believe the training program itself, differs most from those used in other residency programs in the area of organizational management. This area receives relatively greater emphasis in our program because of our belief that the skills required to manage organizational issues, such as interacting with individuals outside medicine (including labor and management), and to understand the business of health care are essential to achieving success in OEM.[6]

TABLE 2
Groupings of Competency Objectives Used to Define External Practicum-Year Residency Modules

General
Critical Review & Appraisal of the Literature
Clinical Occupational & Environmental Medicine
Oral & Written Communication
Personal Development
Clinical Toxicology
The Workplace, Hazard Recognition and Control
Environmental Health, Risk Assessment & Risk Communication
The Worker, Disability & Work Fitness
Population-Based Occupational Medicine
Organizational Management

At the beginning of the supervised practicum-year program, each resident completes a self-evaluation against each competency objective. Each competency is given a self-rating using a five-point Likert scale (1 = lowest, 5 = highest). The self-ratings are reviewed by the resident's site supervisor and faculty preceptor (see section on supervision for an explanation of these terms) to ensure that they are realistic. On the basis of the self-evaluation (revised as necessary after review by the supervisor and the faculty preceptor), an educational plan for the year is developed. The educational plan includes identification of the five major projects; additional educational experiences to strengthen the competency base; clinical areas for strengthening (through case presentations on preceptor site visits, grand rounds or journal club presentations, or by additional clinical experiences); a plan for progressive assumption of responsibility; and, as necessary, rotations or experiences at the University of Pennsylvania or other sites. An important section deals with the plans for the progressive assumption of responsibility by the resident. It might be argued that many of the trainees in UPenn-RES already have a very high level of responsibility as clinic directors, department heads, and so forth, so they need training to help them perform those responsibilities effectively. However, it is a requirement of the Residency Review Committee for Preventive Medicine of the ACGME that training and increased responsibility should proceed together. Accordingly, working with their site supervisor and faculty preceptor, residents develop a plan to progressively assume responsibility to fulfill this requirement and allow progress to be carefully monitored and documented by both the faculty preceptor and the site supervisor.

The Instructional Program

The didactic program is arranged around the six competency-based modules. The competencies in the general module are addressed throughout the year. The five subject-specific modules (workplace; hazard recognition and control; environmental health, risk assessment,

and risk communication; organizational management; and population-based occupational medicine and the worker, disability, and work fitness) are addressed in successive 2-month periods. As part of each module, residents must complete and present a project demonstrating substantive application of the required skills using the populations and resources available at their location. The 2-month modules can be considered to roughly parallel subspecialty rotations within a conventional residency.

The didactic program takes place in Philadelphia over 3 full days (a contiguous Thursday, Friday, and Saturday) each month. At each monthly session in Philadelphia, there are two journal club sessions in which a key recent article is analyzed in depth. After the first month, a resident presents each article. Also, two grand-rounds presentations are given monthly, usually by residents, which are centered on a patient the residents have managed or a challenging situation they have encountered and include visiting speakers. Two series of lecture-discussions are woven throughout the year, one a comprehensive survey of clinical toxicology and the other focused on practical skill development in epidemiology and biostatistics to help residents prepare for their required epidemiological project in the population occupational health module.

In the first month, the remainder of the time is largely devoted to OEM overview, program introduction, project topic identification, socialization, and skill development in communication and using information resources. The final session in Philadelphia is devoted mainly to subjects or skill development needs that have been identified by residents and/or faculty during the year as needing more attention. The bulk of the training session in Philadelphia is devoted to the five subject modules, each of which is assigned 2 months. The programs vary according to the subject matter but incorporate a variety of adult learning techniques. For example, in addressing occupational and environmental health strategies, we have used case studies of selected corporations; in discussing ethical concerns and interpersonal relations, each resident has contributed an experience for analysis and discussion; in developing media communication skills, extensive videotaped sessions in a TV studio allow each resident to role-play in several situations; and in discussing Independent Medical Examinations, each resident brings a report he or she has written for analysis. We have also made extensive use of visiting instructors, such as a full day with a professor of management during the organizational management module. Discussion and interaction are considered critical elements of learning and are strongly encouraged during all of the sessions.

On the final day of each module, the residents present their projects. The projects must address substantive real-life issues, must involve application of skills by the resident, and cannot be limited to a literature review. Projects must also be useful to the organization employing the resident and must not be just an "educational exercise."

Faculty ensure that a sufficient breadth of subjects is addressed by the projects undertaken by the resident group to optimize vicarious learning. For example, in the organizational management module, topics addressed by the class have included a business plan for a clinic expansion, a cost-benefit analysis for a health promotion program, the development of a strategic plan for an occupational health and safety group, the development of a new infectious disease policy for a hospital, a marketing plan for a drug and alcohol program, a patient satisfaction study, and a detailed response to a request for proposals for clinical occupational and environmental health services.

The training at the resident's site of employment is, as explained below, supervised by both a site supervisor and a faculty preceptor. The site supervisor reviews, facilitates, monitors, and evaluates the day-to-day clinical and preventive activities of the resident. The faculty preceptor visits the worksite four times a year. At these visits, the preceptor observes the clinical and interpersonal skills of the resident, discusses patient management and progress on projects, meets with the resident and the site supervisor together, and reviews the resident's progressive assumption of responsibility and any additional skill-developing experiences. Examples of additional experiences arranged for selected residents have included participation in an Occupational Safety and Health Administration inspection, experience at a clinic specializing in occupational skin disease, participation in the investigation of a recreational boating accident, and experience with an employee assistance program. The modular curriculum structure was designed, in part, to allow residents to complete the program in 2 years if necessary, given the various demands on their time. In practice, however, all but two of the 25 residents satisfactorily completed the program in 1 year.

Resident Supervision

Each resident has three levels of supervision for different aspects of the training program.

1. *A full-time faculty preceptor,* who is either the program director or the associate program director. These individuals have overall responsibility for the program and the progress of the residents.

2. *One or more faculty supervisors* for each competency module, who are faculty members at the University of Pennsylvania.

3. *Site supervisors,* who are suitably qualified physicians whose credentials are reviewed as part of the residents' application process.

TABLE 3
Initial and Final Self Assessments and Assessment of Whether Program Met Needs, Against UPenn-RES Competency Objectives for Class of 1999–2000*

Objectives	Initial	Final†	Program Met Needs†
General competency objectives			
Aggregate average	2.97	4.51	4.76
I. Critical review and analysis Critical review and analysis of the literature; awareness and understanding of contemporary issues.	2.75	4.38	4.50
II. Clinical occupational medicine General principles and skills; cardiology; dermatology; ear, nose, and throat; hematology/oncology; infectious disease and biohazards; musculoskeletal disease; neurology; ophthalmology; psychiatry; pulmonary medicine; reproductive medicine.	2.88	4.27	4.67
III. Communication skills Oral communication skills; written communication skills; ability to effectively use presentation software.	3.50	4.75	5.00
IV. Personal behavior, attitudes, and personal development Time management and prioritization; project completion and follow-through; responsibility and ethical behavior; planning; interpersonal relations and conflict resolution.	3.75	4.60	4.85
V. Toxicology Principles of prevention will be applied to investigate, diagnose, and manage patients with illnesses due to toxic industrial agents. Topics: toxicokinetics, carcinogenesis, hydrocarbons and halohydrocarbons, metals and metalloids, gases, dusts, pesticides, resins and polymer systems, nitrogen compounds, and chemical warfare agents.	1.96	4.54	4.79
Clusters of specific competency objectives			
I. The workplace: hazard recognition, evaluation, and control			
Aggregate average	2.48	4.51	4.51
A. Recognize major types of hazards Physical, chemical, biological, psychosocial.	2.81	4.63	4.63
B. Perform hazard characterization Perform walk-through assessment for safety and health; interpret and appropriately request industrial hygiene surveys.	2.63	4.38	4.38
C. Interpret existing standards OSHA safety standards (hazards communication, lock-out, tag-out); OSHA PEL; OSHA general duty clause; unofficial standards such as ACGIH TLVs and BEIs; EPA standards.	2.61	4.54	4.57
D. Ergonomics Recognize and evaluate ergonomic hazards; perform a simple ergonomic job analysis for specific hazards, including lifting and repetitive motion; apply corrective workplace design and work practice interventions and controls.	2.92	4.50	4.50
E. Recognize, evaluate, and apply principles of control to physical hazards Mechanical and electrical hazards; vibration; ionizing radiation (radioactive contamination); non-ionizing radiation; lasers; noise (sound-level measurements); high and low pressure (dysbarism); high and low temperature; heat stress.	1.98	4.25	4.15
F. Hazard communication Interpret and advise on content of material safety data sheets.	2.50	4.75	4.75
G. Develop and monitor medical programs Respirator clearance, hearing conservation.	3.50	4.63	4.50
H. Industrial Hygiene Control Recognize industrial hygiene hazards and principles of general program design; identify key principles in the collection of industrial hygiene data; perform an environmental risk analysis; recommend appropriate personal protective equipment; assist in development of administrative controls; recommend the need for engineering controls; understand the regulatory context; communicate industrial hygiene findings and their consequences.	2.34	4.69	4.69
I. Safety and accident investigation Perform an accident investigation using principles of a fault tree.	1.25	4.00	4.25
J. Workplace culture Identify important characteristics of workplace culture at a workplace; formulate measures to change workplace culture with respect to health and safety.	2.00	5.00	5.00
II. The worker: disability and work fitness			
Aggregate average	2.95	4.62	4.62
A. Disability prevention and management Demonstrate ability to identify issues early; recognize risk factors; manage the effects on illness or injury of psychological issues, substance abuse, family; recommend appropriate accommodations, both permanent and temporary; develop prevention plan for recovered employees.	2.72	4.44	4.44
B. Make appropriate recommendations with regard to the Americans with Disabilities Act for undue risk, direct threat, accommodations, preplacement examination.	3.06	5.00	5.00
C. Fitness for duty and return to work Conduct and interpret functional work capacity evaluations; apply impairment ratings to examinations results; conduct DOT examinations; conduct FAA examinations; recognize special needs and make appropriate recommendation with regard to heavy exertional work, chemical hazards, hazardous waste, pregnant workers, travel, physical handicaps, injury or illnesses.	2.66	4.50	4.50
D. Understand and interpret regulations and the role of government agencies, workers' compensation, DOT, FAA, Family and Medical Leave Act.	3.00	4.75	4.75
E. Relate recommendations to workplace culture Develop recommendations that are feasible and likely to succeed in terms of business imperatives and organizational culture.	3.00	4.75	4.75
F. Work/rest cycles Relate effects of shift work on circadian rhythm and sleep/wake cycles; recommend methods for fatigue reduction in multiple time zone flights; develop rotating shift schedule.	2.92	4.50	4.50
III. Organizational management			
Aggregate average	2.19	4.67	4.64

Table 3 continues

TABLE 3
Continued

Management:	2.21	4.75	4.73
A. Develop a business plan for an occupational and environmental health service.	2.00	4.75	4.75
B. Apply principles of teamwork and diversity in management activities.	2.25	4.75	4.75
C. Apply methods of strategic planning in an occupational health setting.	2.25	4.75	4.75
D. Work effectively with employee representatives and organized labor.	2.25	4.75	4.75
E. Be aware of the goals and major areas of human resource management.	2.25	4.75	4.75
F. Audit and review an occupational health program.	2.00	4.75	4.75
G. Apply monitoring tools and appreciate the health consequences of performance measurement, including performance appraisal.	3.00	4.75	4.75
H. Communicate effectively with the media.	2.00	4.75	4.75
I. Market an occupational health program.	2.25	4.75	4.75
J. Design a program, establish performance indicators, and evaluate effectiveness.	2.00	4.75	4.50
K. Adapt behavior to a specific corporate context and culture.	2.00	4.75	4.75
L. Apply conflict resolution skills in occupational and environmental health settings.	2.25	4.75	4.75
Health administration and economics	2.17	4.58	4.54
A. Be able to strategically position occupational and environmental health services within an organization's human resource policies and practices.	2.25	4.50	4.50
B. Apply principles of quality assurance and management in an occupational health program, including quality management, risk management, demand management, case management, utilization management, and practice guidelines.	2.25	4.50	4.75
C. Apply a working knowledge to an occupational medicine program and provide consultation for health care delivery system, insurance concepts, and benefit design.	2.00	4.75	4.50
D. Develop and monitor cost-containment measures.	2.00	4.75	4.50
E. Determine the relative merits of outsourcing or in-service provision of occupational and environmental health services.	2.00	4.50	4.50
F. Perform a simple cost-benefit analysis for a health measure.	2.50	4.50	4.50
IV. Environmental health and risk assessment			
Aggregate average	1.64	4.47	4.57
A. Perform a risk assessment.	1.50	4.25	4.50
B. Recognize and apply principles of "community right to know." Interact positively with community advisory panels.	1.00	4.50	4.50
C. Interpret results of environmental monitoring	1.50	4.75	4.75
D. Identify and make recommendations concerning human health effects (pulmonary, reproductive, neoplastic, other).	1.81	4.19	4.25
E. Assess and communicate the risks from and make diagnostic evaluations of the health effects from environmental exposure: release of industrial chemicals; human and animal wastes; outdoor air pollution (priority pollutants); indoor air pollution; water pollution; hazardous waste (chemical, radioactive, infectious); radon; household chemicals; pesticides.	1.71	4.54	4.67
F. Hazard communication Develop a risk-communication program for a specific community and risk.	1.50	4.50	4.75
G. Understand and interpret regulations and the role of government agencies (EPA)	2.25	4.25	4.50
H. Understand the role of quality and responsible care in environmental issues	2.00	4.50	4.50
V. Population-based occupational medicine			
Aggregate average	2.15	4.58	4.65
A. Ethics Address issues related to individual privacy and confidentiality of records; interpret governmental regulations and make appropriate recommendations; appreciate and be able to handle different roles, including whose agent the physician is under in different circumstances; address issues contained in a standard code of ethics (eg, the ACOEM Code of Ethical Practice).	2.63	4.75	4.75
B. Record-keeping Recognize regulatory requirements for OSHA record-keeping.	2.25	4.75	4.75
C. Computers and informatics Be able to use the following types of applications in an occupational health setting: database management, spreadsheets, word processing, patient records, billing, performance tracking, disability management.	2.75	4.50	4.68
D. Health promotion and clinical prevention Develop and implement population-based programs in the following areas: fitness, health promotion, nutrition, smoking cessation; apply health risk assessment tools to populations; apply screening to populations; develop intervention for targeted high-risk groups.	1.96	4.43	4.50
E. Statistics and epidemiology Design a simple epidemiological study; interpret the results of an epidemiological study; prepare a risk assessment based on existing data; design a medical surveillance program; recognize and act on regulatory reporting requirements.	2.05	4.50	4.50
F. Emergency planning Hazardous materials incidents; disaster planning.	1.63	4.50	4.75
G. Employee assistance programs Recognize behavioral, psychiatric, and substance abuse issues in the workplace; select appropriate counseling services.	2.25	4.75	4.75
H. Develop and conduct workplace health surveillance Medical surveillance programs; data analysis of injury and illness experience; identify sentinel health events; perform simple cluster analysis; derive appropriate intervention from surveillance data.	1.65	4.50	4.50
Overall average, all competencies	2.39	4.53	4.62

* OSHA, Occupational Safety and Health Administration; PEL, permissible exposure limit; ACGIH, American Conference of Governmental Industrial Hygienists; TLV, threshold limit value; BEI, biological exposure index; EPA, Environmental Protection Agency; DOT, Department of Transportation; FAA, Federal Aviation Administration.

† All ratings were made on a five-point Likert scale ranging from 1 (lowest) to 5 (highest). For each grouping of competencies and for overall scores, ratings given for each component competency have been summed. Each resident made a self-assessment of his or her competency with respect to each competency objective of the program on the first day of the residency. Self-assessment using the same five-point scale was repeated at the end of the program against the same competency objectives. In addition, at the end of the program the resident assessed whether the program met his or her needs, again for each competency objective, and using a five-point scale.

The *faculty preceptor* makes at least four site visits to the resident, maintains ongoing contact with the site supervisors and the faculty competency module supervisors, and monitors the progress of the resident toward program goals. The preceptor also evaluates the resident's performance to ensure that the resident has achieved the required general competency objectives. The *faculty supervisor(s)* develops the competency modules together with the residency program director. The faculty supervisor(s) for each module is in contact with the resident before the start of the module to assist with the delineation and preparation of the selected project and with other guidance as needed. The faculty supervisors monitor the residents' performance and complete an evaluation for each resident against each of the competency objectives for that module.

Each resident has a *site supervisor* who is responsible for monitoring the training activities at the worksite. The site supervisor assists in the preparation of the yearly educational plan, including the identification of meaningful projects for the resident to complete, and, together with the resident and preceptor, signs off on that plan. The site supervisor monitors the progress of the resident and completes the required formal evaluations, which occur at least every 6 months. The evaluations concentrate on patient care skills and assess skill development in the five specific competency module areas. The site supervisor also supervises and monitors the progressive assumption of responsibility by the resident throughout the practicum-training year. During the first site visit, the *preceptor* ensures that the site supervisor understands the required supervision and monitoring. At subsequent visits, the resident's progress against the goals is reviewed by both the preceptor and the site supervisor.

As described above, the design of the program ensures that each resident is monitored for all of the competency objectives and that the satisfactory performance of each resident is documented against each of the objectives.

Outcome Evaluations and Quality Enhancement

Both formative and summative evaluations are used.[7] Formative evaluations, such as resident reviews of each module and feedback from faculty and the Residency Advisory Committee, are used to ensure continuous improvement and relentless adaptation to training needs.

The evaluations of program outcomes have been achieved using three independent outcome measures: resident self-evaluations, faculty evaluations, and the success of graduates in the ABPM examination in Occupational Medicine.

Resident self-evaluations are performed at the start and at the conclusion of the program. The evaluation methods have been gradually improved over the life of the program. Currently, each resident self-assesses his or her competency with respect to each competency objective of the program using a five-point Likert scale on the first day of the residency. Self-assessment using the same five-point scale is repeated at the end of the program against the same competency objectives. In addition, at the end of the program, the resident assesses whether the program met his or her needs for each competency objective using a five-point scale.

Table 3 presents the results of the residents' self-evaluation against the program competency objectives as rated at the beginning and end of the year. For the second assessment, the resident was blinded to the results of the first assessment. The table also presents a rating of whether the program met the residents' individual needs with respect to each competency objective. The possible ratings ranged from 1 (lowest) to 5 (highest). Aggregate values are also presented for the competencies within each module, for the five competency groups within the general module, and for all competencies. Because of the concern about the efficient use of training resources, we considered it important to assess whether the program met an individual's needs rather than to merely assess the overall adequacy of the instruction in a given subject matter. It is clearly important to address the individual needs of the program participants in the context of ensuring the quality of the presentation of the course materials. This is particularly salient in this program because the trainees are already highly experienced and motivated. As seen in Table 3, the overall average rating for all competencies was 2.39 of a possible 5 at the start of training, 4.53 of 5 at the completion of training, and 4.62 of 5 for satisfaction that the program met training needs. In each module, the average competency rating at the commencement of the year was less than 3 of 5, the rating at the end of the year was greater than 4.4, and the rating for meeting training needs was greater than 4.5. The self-evaluation results indicate that the program was rated very highly both in terms of a positive change in all groups of competencies and in satisfaction with the training program. Faculty members believe that the ratings were realistic, because the skills rated low at the start of the year did not seem to be well-developed at that time, and because subjects given low ratings at the end of the program accurately reflected subjects that received less attention during the training year.

Faculty members evaluate the competency of each resident against the program competency objectives at the end of each relevant module using a four-point scale: 4 (superior), 3 (satisfactory), 2 (marginal), and 4 (unsatisfactory). Residents achieving rating of 1 or 2 must perform additional work and/or repeat the module until a satisfactory rating is achieved for each competency. Table 4 shows the aggregate results of faculty evaluations for the 1999-to-2000 class. The evaluations vary considerably

TABLE 4
Average Value for Faculty Ratings of Residency Competency for 1999-to-2000–Year Residents by Competency Module Grouping* (on a scale of 1 lowest to 4 highest)*

Module	Rating
General Competencies	
Critical Review and Analysis	3.65
Clinical Occupational Medicine	3.8
Communication Skills	3.6
Personal Behavior, Attitudes & Personal Development	3.8
Clinical Toxicology	3.55
The Workplace	3.8
Environmental Health, Risk Assessment & Risk Management	3.2
Organizational Management	3.0
Population-Based Occupational Medicine	3.9
The Worker, Disability & Work Fitness	3.1

* Scale: 1 (lowest) to 4 (highest). The applicable faculty provided ratings for each resident at the end of the training module against each competency. The scale used for ratings was 1 (unsatisfactory), 2 (marginal), 3 (satisfactory), 4 (superior). The values in the table are the average of all ratings within the competency group for all residents.

according to the subject matter. In all cases, the aggregate rating was greater than 3 of a possible 4. The higher scores were achieved for population-based occupational medicine; clinical occupational medicine; and the workplace. The lowest scores were achieved for organizational management; the worker, disability, and work fitness; and environmental health, risk assessment, and risk management. This variation probably reflects at least in part the sophistication of residents with respect to the underlying subject matter after an MPH degree and a traditional medical career.

The residents' performance on the ABPM certification examination has also been monitored; 86% of residents completing the program have sat for the ABPM examination at the first available opportunity after becoming eligible. Eight of nine (89%) of those sitting for the examination have passed on the first attempt, with 100% passing the occupational medicine portion of the examination. This compares at least satisfactorily with the national average ABPM pass rates for 1998 to 1999 and 1999 to 2000, respectively, of 73% and 71% for candidates who have completed a residency program, 63% and 50% for those who have not completed a formal residency, and 70% and 64% for all candidates overall (ABPM, personal communication).

Although several residents have received significant promotions since completing the program, because of the small numbers and relatively short duration of the program, the data do not yet allow a sound evaluation of any impact of the training on career trajectory.

The major elements of our quality management program include a clear definition of program objectives for program planning; process documentation and the use of three independent measures of outcome; continuous improvement; and relentless adaptation to training needs.

Economics of External Residency Training

There has been concern about the continuing role of the federal government in supporting graduate medical education, which it does mostly through medicare funding.[8] Those who oppose this method of federal funding cite the substantial, if not excess, supply of physicians and point out that it is unusual for the government to subsidize postgraduate training in any field. Wilenski[9] has stated "physicians in training provide services for which they should be paid, and they are. They also receive training for which they should pay. If they did, it would probably force a reconsideration of the length and content of residency programs. Disadvantaged physicians, physicians in certain specialties or physicians willing to practice in areas where there is a shortage of care could receive grants, loans or loan forgiveness from the federal government."

Although there must be a strong case that preventive medicine and occupational medicine are specialties that should receive substantial subsidies for training in practice, medicare and/or institutional funds are rarely available to support occupational medicine residencies. This failure to use the usual medicare source to fund preventive medicine residencies persists, despite an exception to the usual medicare rules that only 3 years of training can be supported from medicare funds: 5 years of training can be funded for a combination of internal medicine and preventive medicine.

In any case, UPenn-RES works on a simple and economically rational basis. Those who employ our residents reimburse them for the work they do. The resident pays tuition to UPenn-RES for the training received. The employer may subsidize or pay for all or part of the resident's training, based on the existing personnel policies of the employer. Today approximately one-third of trainees receive some contribution from their employer.

UPenn-RES is fiscally efficient from a number of points of view. The resident can maintain his or her existing employment and thus keep salary and benefit provisions while training. For residents outside the greater Philadelphia area, there is no need for relocation during the training period. These factors chould be particularly beneficial in the current work climate, in which there is often little certainty of long-term employment.

For 3 of the 4 years of program operation, additional limited funds have been available through a NIOSH training grant for partial tuition and travel costs. These funds are awarded to residents according to community need, based on the rationale that public funds should be used to aid the disadvantaged. The criteria of need we use include service to an underserved population; difficulty in accessing a suitable training program (eg, remote location, location where there is no training, family responsibilities); specific regional workforce need; and service to special populations at risk, including minority and disadvantaged workers. To date, approximately one-quarter of the entering residents have received direct assistance from NIOSH funds. There have been several instances in which deserving residents could not have entered the program without the availability of this NIOSH funding.

Discussion

The "external" supervised practicum-training year described here has successfully met its competency learning objectives, as measured by resident self-evaluations demonstrating competency enhancement, faculty evaluation of resident competence following training, and achievement in the ABPM certification examination. It has also met the perceived training needs of the residents.

We believe that this program represents at least a third generation of preventive medicine residency programs in OEM. Before the late 1970s practicum-year experience was, in retrospect, quite loosely organized mainly through outplacements to health departments, corporate medical departments, and other sites. In the second generation of programs in occupational medicine, residents completed a largely defined set of rotations, for example, to one or more industries, a government department, a union, a University-based occupational medicine clinic, and a variety of subspecialties relevant to occupational medicine. Thus, residents received training and experience in a variety of settings and subject areas that was akin to residency training in internal medicine. UPenn-RES represents a third evolutionary stage in that the training setting remains generally constant, and the resident systematically enhances competency skills across the range of competencies required by OEM specialists in a way that builds on prior training and experience. The nature of this training is such that it can usually be obtained with the resident working in one job site where he or she is employed full-time, although supplementation by additional experiences may be necessary. This type of training may be more effective for trainees who already have substantial clinical experience, as is the case for those who have entered UPenn-RES, although as yet there are no data to address this question.

There seems to be a need for new training pathways for physicians desiring to specialize in OEM. There are no good current data on manpower needs for OEM specialists. According to the Institute of Medicine Subcommittee on Physician Shortage in Occupational and Environmental Medicine,[10,11] there was a shortage of from 3100 to 4700 board-certified OEM specialists in 1990, although the accuracy of the projections might be questioned and they might not apply at all in today's market. In the period since the report, some growth has occurred in accredited residencies, but it has not resulted in a proportional growth in the number of residents trained.[12] From 1989 to 1994, the number of accredited occupational medicine residencies increased by 54%, from 26 to 40, with an output from traditional residency training over that period of about 70 to 80 per year. The high proportion (approximately 75%) of trainees entering the Upenn-RES program who received their MPH training through distance-learning, on-job, on-campus, or executive-release programs supports the view that we are bringing a group of physicians into specialist training in OEM who would not have taken OEM residency training without the availability of new access both to MPH or equivalent training and to an "external" supervised practicum year. At this time the size of this pool is unknown.

Several aspects of Upenn-RES deserve comment, because our experience leads us to believe they are critical success factors. First, this type of program is very demanding of faculty time, much more so than a conventional residency. We have the involvement of a large and exceptionally well-qualified faculty, so all modules can be taught by professional leaders. Assembling such a diverse faculty willing to contribute sufficient time and effort to teaching may not be possible outside of a few major metropolitan centers. The recruitment of volunteer faculty is aided by the enjoyable nature of the interaction with mature adult trainees who are motivated and dedicated. Second, UPenn-RES has a very high level of personal interaction. There are approximately 300 hours of face-to-face contact with the program instructors, preceptors, and other residents. Without these interactions and the learning stimulation obtained from other residents, the program would be very different. The high level of interaction with faculty seems particularly important when residents have completed their academic year through a distance-learning program. Third, this level of interaction requires a critical mass of residents. Our experience leads us to the view that at least four residents should be in each class and that the optimal number may be closer to eight. Fourth, the close mentoring arrangement fostered by the program seems to assist in personal and career development for residents, especially for those working in larger organizations. This includes unusual access to higher management facilitated by work on some projects.

The modular structure is also designed to allow physicians who need periodic recertification by the ABPM (ie, those certified after 1997) to take one or more elements of the program to bring their skills up-to-date or to expand their range of competence.

The residency presents a distinctly different training and career-development experience to that which might otherwise be obtained through CME classes and courses, even a CME selection that might cover similar didactic content. These differences include a structured curriculum to systematically acquire the desired competencies; an emphasis in acquiring skills rather than just "book-learning"; the teamwork, socialization, and peer support that develop among a residency group; and individualized attention to personal and professional growth through the supervision and mentoring. Because of these factors, we believe that the supervised residency offers a much richer and more fulfilling training and development experience than that which could be obtained through CME.

This innovative, competency-based, supervised practicum-year training program demonstrates that by using principles of adult learning, we can successfully train physicians making a mid-career shift to OEM, as measured by resident self-evaluation, evaluation of competence by experienced faculty, and success in ABPM specialty examinations.

Acknowledgments

We acknowledge with great gratitude the contributions of the faculty members (Lloyd Tepper, MD, ScD; Phillip Lewis, MD, MPH; Robert Bonner, MD, MPH; Natalie Hartenbaum, MD, MPH; Jeffrey Erinoff, DO, MPH; Richard Lippin, MD, MPH; Marcia Comstock, MD, MPH; Fran Shofer, PhD) and the members of the Residency Advisory Committee (Joseph Cannella, MD, MS; Marjorie Bowman, MD, MPA; William Baxt, MD; Anita S. Curran-Smith, MD, MPH; Patrick B. Gillespie; Paul Kleindorfer, PhD; Lloyd Tepper, MD, ScD; Theodore Them, MD, MPH; PhD; David Tollerud, MD**)** who have made this program possible. We acknowledge the support and helpful advice of Robert Goldberg, MD, President of ACOEM. This program was supported in part by NIOSH training grant #2T01CCT314437.

References

1. Root PR, DeHart RL. Qualifying for certification in the specialty of occupational medicine. *J Occup Environ Med*. 1995;30:446–470.
2. DeHart R. Establishing eligibility for examination in the specialty of occupational medicine. *J Occup Med*. 1986;28:303–305.
3. Accreditation Council for Graduate Medical Education. *Graduate Medical Education Directory*. Chicago: ACGME; 1999–2000.
4. American Board of Preventive Medicine. *Study Guide Materials, Exam Content Outlines*. ABPM; 1999.
5. American College of Occupational and Environmental Medicine Panel to Define the Competencies of Occupational and Environmental Medicine. Committee Report: Occupational and environmental medicine competencies—v1.0. *J Occup Environ Med*. 1998;40:427–440.
6. Emmett EA. What is the strategic value of occupational and environmental medicine—observations from United States and Australia. *J Occup Environ Med*. 1996;38:1124–1134.
7. Anderson SB, Ball S, Murphy RT. *Encyclopedia of Educational Evaluation.* San Francisco: Jose-Bass; 1981:175, 406.
8. Iglehart JK. Medicare, graduate medical education. *N Engl J Med*.1998:338:402–407.
9. Wilenski GR. Who will pay for graduate medical education. *N Engl J Med*. 1998; 339:52–53.
10. Institute of Medicine. *Role of the Primary Care Physician in Occupational and Environmental Medicine.* Washington, DC: National Academy Press; 1988.
11. Castorina J, Rosenstock L. Physician shortage in occupational and environmental medicine. *Ann Intern Med*. 1990; 113:983–986.
12. Frumkin H. Too many residencies? *J Occup Med*. 1994;36:675–676.