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ARTICLES

Analysis of Medical Screening and Surveillance in 21 Occupational Safety and Health Administration Standards: Support for a Generic Medical Surveillance Standard

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Twenty-one Occupational Safety and Health Act (OSHA) standards were identified which contain medical service provisions intended to help in the identification and control of harmful health effects of workplace exposures. The utility and effectiveness of these provisions have not previously been evaluated. All 21 standards were reviewed and assigned numerical scores for each of 24 potential medical program elements. Several of these elements were combined to calculate Quality Control, Screening Utility, and Surveillance Utility scores for each standard. Total scores varied greatly, suggesting a lack of consistency and uniformity which was even more obvious when the actual regulatory language was examined. The mean Quality score was only 26% of potential points. Seventeen of 21 standards received less than half the total possible Quality score. When arrayed on a two by two matrix only two standards scored above 50% for both Screening and Surveillance Utility. It was concluded that the medical service provisions in OSHA standards are lacking in consistency and coherence. Two major shortcomings are the lack of quality control elements and the absence of surveillance features which would permit medical program results to be utilized for prevention activities including the identification and control of workplace hazards. A generic occupational medical surveillance standard could address these current weaknesses. Elements of such a generic standard are proposed.

Key words: screening, surveillance, OSHA standards, occupational health, medical monitoring, prevention

INTRODUCTION

The Occupational Safety and Health Act of 1970 [29 United States Code (U.S.C.) 651 et seq.] authorizes the Secretary of Labor to set any standard for workplace exposure to hazardous chemicals and physical agents which "most adequately assures, to the extent feasible, on the basis of the best available evidence, that no employee will suffer material impairment of health or functional capacity even if such employee has regular exposure to the hazard dealt with by such standard for the

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TABLE I. 21 OSHA Standards, Scoring of Medical Provisions

Standard, name	Standard, number	Total score	Quality score	Screening score	Surveillance score
Acrylonitrile	29 CFR 1910.1045	.46	.29	.67	.20
Arsenic, inorganic	29 CFR 1910.1018	.48	.21	.75	.40
Asbestos	29 CFR 1910.1001	.52	.36	.83	.30
Benzene	29 CFR 1910.1028	.67	.64	.92	.50
Bloodborne pathogens	29 CFR 1910.1030	.33	.14	.50	.00
Cadmium	29 CFR 1910.1027	.77	.64	.92	.70
Carcinogens[a]	29 CFR 1910.1003 to 1016	.25	.00	.50	.30
Coke ovens	29 CFR 1910.1029	.40	.14	.75	.30
Cotton dust	29 CFR 1910.1043	.56	.64	.75	.50
Dibromochloropropane	29 CFR 1910.1044	.42	.21	.75	.30
Ethylene oxide	29 CFR 1910.1047	.44	.14	.75	.30
Field sanitation	29 CFR 1910.142	.04	.07	.08	.00
Fire protection	29 CFR 1910.156	.08	.07	.08	.00
Formaldehyde	29 CFR 1910.1048	.56	.14	.92	.60
Hazardous waste operations	29 CFR 1910.120	.40	.14	.67	.30
Hearing conservation	29 CFR 1910.95	.38	.43	.33	.30
Lead	29 CFR 1910.1025	.67	.64	.92	.50
Laboratories	29 CFR 1910.1450	.17	.07	.42	.10
Methylenedianiline	29 CFR 1910.1050	.52	.14	.92	.40
Respirator program	29 CFR 1910.134	.15	.07	.42	.20
Vinyl chloride	29 CFR 1910.1017	.40	.14	.75	.40
	Mean	.41	.26	.65	.31
	Standard deviation	.22	.20	.30	.21

[a]OSHA carcinogen standard covers 4-Nitrobiphenyl, α-Naphthylamine, methyl chloromethyl ether, 3,3'-Dichlorobenzidine and its salts, bis-Chloromethyl ether, β-Naphthylamine, Benzidine, 4-Aminodiphenyl, Ethyleneimine, β-Propiolactone, 2-Acetylaminofluorene, 4-Dimethylaminoazobenzene, N-Nitrosodimethylamine.

period of his working life" [Occupational Safety and Health Act Section 6(b)(5)]. In addition to establishing requirements for permissible exposure limits, engineering controls, work practices, and personal protective equipment, "where appropriate, any such standard shall prescribe the type and frequency of medical examinations or other tests which shall be made available, by the employer or at his cost, to employees exposed to such hazards in order to most effectively determine whether the health of such employees is adversely affected by such exposure" [Occupational Safety and Health Act Section 6(b)(7)].

Since 1970 the Occupational Safety and Health Administration (OSHA) has published 21 standards which include provisions for medical examinations and related tests (Table I). There has been no systematic consideration of the content or utility of these medical regulations. One recent paper reported on the enforcement of medical requirements in the lead, ethylene oxide, and formaldehyde standards [Schwartz et al., 1992]. Two papers have reviewed the content and implementation of medical requirements in the hazardous waste operations and emergency response standard [Melius, 1990; Udasin et al., 1991].

The analysis in this paper utilizes a distinction made previously [Silverstein, 1990] between two concepts which are frequently but incorrectly used interchangeably: screening and surveillance. Screening is the application of clinical procedures to

members of a group, often chosen to be asymptomatic but at high risk, for the purpose of identifying those needing further individual attention. The National Institute for Occupational Safety and Health (NIOSH) considers the purpose of screening to be "detecting organ dysfunction or disease before an individual would normally seek medical care" [Halperin et al., 1986]. Screening is inherently a tool for secondary prevention, the early diagnosis, and treatment of disease. Its focus is on individuals in a population.

Surveillance, which has been described as "the ascertainment of information for the purpose of detecting changes in trend or distribution in order to initiate intervention, control or other investigation" [Last, 1986], focuses on the population itself. It "means the continued watchfulness over the distribution and trends of incidence . . ." [Langmuir, 1963]. Surveillance starts with the collection of information about individuals and then aggregates this information in order to examine patterns within a population. It is essentially a tool for primary prevention, the identification and elimination of the causes of disease.

Some tests may be better suited to either screening or surveillance than to the other. For example, a surveillance program which uses a medical test to distinguish a workplace with a high rate of health effects from one with a lower rate may be successful even if the test yields so many false negative results that it has limited utility for satisfying the clinical needs of individuals. Other tests may be useful for both screening and surveillance, depending upon how the results are actually used. A physician, for example, who uses lung function testing on a population to identify individual patients in need of counseling and treatment has derived screening value from the tests. These screening results, however, can only serve a surveillance function if the physician uncouples the information from the individual patients and evaluates patterns of findings within the group (aggregate analysis) or makes an attempt to link the results with some feature of the environment which may affect additional people (sentinel event analysis).

A major premise of this paper is that medical and biological monitoring of workers can serve a narrow, clinically oriented secondary prevention purpose (screening) or can contribute to a broader, public health oriented primary prevention strategy (surveillance), depending upon the manner in which the medical services are organized and used. A numeric scoring scheme developed for this analysis was used to examine how the existing OSHA medical service provisions are actually designed to perform.

MATERIALS AND METHODS

All OSHA standards promulgated since 1970 were examined and 21 were identified which contained requirements for employee medical evaluations, examinations, or tests. The OSHA carcinogen standard (29 Code of Federal Regulations [CFR] 1910.1003 to 1910.16) covers 13 different chemical carcinogens with virtually identical provisions and was counted only once.

Twenty-four potential features of a comprehensive medical program were defined. These included elements associated with medical examinations and tests (e.g., examination schedule, elements of occupational history), record keeping (e.g., access to records, confidentiality), quality control (e.g., laboratory certification, provider credentials), and management of results (e.g., medical removal provisions, fitness to

TABLE II. Scoring Rules for Medical Program Elements in OSHA Standards*

Program element	Score = 0	Score = 1	Score = 2
1. Physical examination	None	Required, but nonspecific	Required, with specific elements
2. Medical history	None	Required, but nonspecific	Required, with specific elements
3. Occupational history	None	Required, but nonspecific	Required, with specific elements
4. Laboratory tests	None	Required, but nonspecific	Required, with specific elements
5. Examination schedule	Baseline only or emergency/ complaint only	Baseline + periodic	Baseline + periodic + emergency/complaint
6. Eligibility	Nonspecific	Linked to qualitative exposure assessment	Linked to quantitative exposure assessment
7. Provider credentials	None	Professional degree specified	Degree + specialized training or experience
8. Laboratory certification	None	Certification required	Certification + proficiency testing
9. Guidelines for interpretation of results	None	Minimal	Comprehensive
10. Test result norms for comparison	None	Norms specified	Norms specified + required comparisons with baseline
11. Guidelines for treatment or care	None	Minimal	Comprehensive
12. Facilities and equipment	None	Minimal specifications	Comprehensive specifications
13. Provider training: standard specific	None	Minimal	Comprehensive
14. Protocols for examinations and tests	None	Minimal	Comprehensive
15. Employee records: contents	None	To include tests or exams or other material	To include tests, exams, and other material
16. Employee records: confidentiality and privacy	None	Limits on information about nonoccupational conditions	Explicit protections for confidentiality and privacy
17. Physician written opinions	None	Required, but nonspecific	Required, with specific elements
18. Employee records: preservation and storage	Less stringent or specific than 29 CFR 1910.20	Equivalent to 29 CFR 1910.20	Exceeds 29 CFR 1910.20
19. Access to medical records	Less stringent or specific than 29 CFR 1910.20	Equivalent to 29 CFR 1910.20	Exceeds 29 CFR 1910.20
20. Fitness to work recommendations	None required	Required, but nonspecific	Required, with specific guidelines
21. Counseling and referrals	None	Provision of results required, but without specific guidelines	Provisions of results + specific guidelines for counseling or referrals
22. Medical removal provisions	None	Medical removal requirements specified	Medical removal requirements + medical removal protection benefits
23. Epidemiology	None	Aggregate data description required	Aggregate data analysis required
24. Environmental intervention	None	Provider walkthrough or inspection required	Workplace evaluations or changes required

*29 CFR 1910.20: OSHA rule on access to employee exposure and medical records. Program elements included in Quality Control score: nos. 7, 8, 9, 11, 12, 13, 14; program elements included in Screening Utility score: nos. 1, 2, 3, 4, 9, 11, 20, 21, 22; program elements included in Surveillance Utility score: nos. 3, 5, 10, 23, 24.

work determinations). Each standard was scored on a three-level scale (0,1,2) for each of these 24 program elements. The complete listing of program elements with scoring criteria is presented in Table II.

Seven of the 24 program elements were combined to generate a Quality Control score for each standard, based on a judgment about which elements were most necessary to assure uniformity, consistency, and attainment of professional standards in the delivery of services. These elements include:

1. No. 7: provider credentials, including professional degrees and specialty training or experience;
2. No. 8: laboratory certification, including proficiency testing;
3. No. 9: guidelines for interpreting the results of tests and examinations. For example, the asbestos standard requires that chest x-rays be interpreted in accordance with a professionally accepted classification system and that comparisons be made with a set of reference radiographs.
4. No. 11: Guidelines or protocols for the appropriate follow up of positive findings, including any additional required testing, examinations, or protective measures.
5. No. 12: Specifications for facilities and equipment. For example, the cotton dust standard requires that spirometers meet criteria for accuracy, volume capacity, and other operating characteristics.
6. No. 13: Provider training specific to the requirements of the standard. For example, the benzene standard requires that pulmonary function testing be performed by a person who has completed a training course in spirometry.
7. No. 14: Protocols for conducting examinations and tests, such as the specifications in the benzene standard for peripheral blood smear procedures.

Nine program elements were combined to generate a Screening Utility score, based on a judgment about which elements were most necessary to assure the generation and use of information relevant to the delivery of individual clinical services. These elements include:

1. No. 1: Requirements for physical examination, including specificity and extent.
2. No. 2: Requirements for medical history, including specificity and extent.
3. No. 3: Requirements for occupational history, including specificity and extent.
4. No. 4: Laboratory test requirements, including either unspecified testing or a required battery of tests.
5. No. 9: Guidelines for the interpretation of test and examination results.
6. No. 11: Guidelines for the treatment or care of employees with abnormal results.
7. No. 20: Requirements that the physician make a judgment about an employee's fitness for work, including the need for special protection or removal.
8. No. 21: Requirements for providing employees with results of examinations, including guidelines for counseling or referring employees for further evaluation.

Six other program elements were combined to generate a Surveillance Utility score, based on a judgment about which elements were most necessary to assure the evaluation of aggregate or sentinel data and the application of these data to prevention interventions. These elements include:

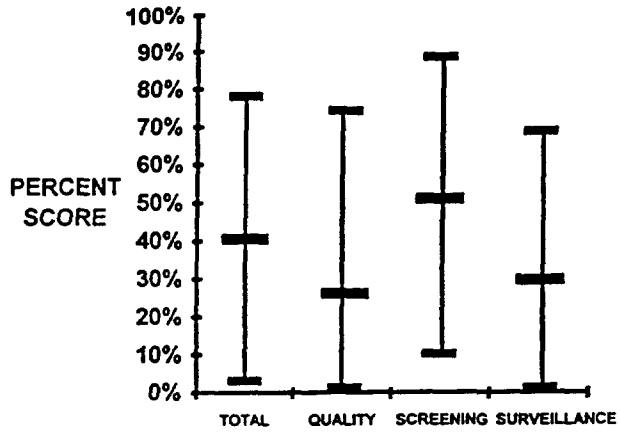

Fig. 1. Mean scores and ranges for medical provisions in 21 OSHA standards (see Table I for individual scores).

1. No. 3: Requirements for occupational history, including specificity and extent.
2. No. 5: Examination schedule, including baseline and periodic evaluation.
3. No. 10: Requirements for comparing test results with normative levels and with baseline results.
4. No. 23: Requirements for aggregate data description or analysis.
5. No. 24: Requirements for environmental evaluation or intervention in response to examination and test results.

RESULTS

Each of the 21 standards received a Total, Quality Control, Screening Utility, and Surveillance Utility score expressed as the percentage of the highest potential score for that particular index (Table I). Mean scores and ranges for the four scoring indices are presented in Figure 1. Total scores ranged from 77% of the maximum possible for the cadmium standard to 4% for the field sanitation standard with a mean score of 41%. Fourteen of the 21 standards analyzed received less than half the total possible score. Scores on the Quality index ranged from a high of 64%, shared by the benzene, cadmium, cotton dust, and lead standards, to a low of zero for the carcinogens standard. The mean Quality score was 26%; 17 of the 21 standards received less than half the total possible Quality points.

Screening Utility scores varied from 89% (cadmium and lead) to 11% (field sanitation) with a mean of 52%. Surveillance Utility scores varied from 70% (cadmium) to zero (bloodborne pathogens, field sanitation, and fire protection) with a mean of 31%. The mean scores for Screening Utility and Surveillance Utility differed significantly from each other ($p < .01$, t-test).

The relationship between Screening Utility and Surveillance Utility scores was examined by plotting the two scores for each standard on a two-dimensional matrix (Figs. 2, 3). Four quadrants were defined according to whether scores were above or below the 50% level for each of the two indices. Only two standards (cadmium and

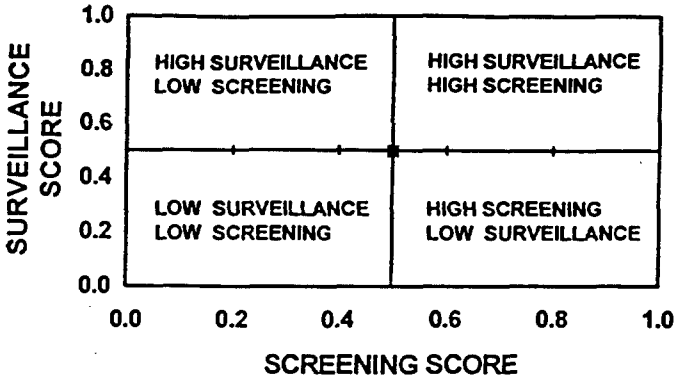

Fig. 2. Utility of medical programs (see Table II and text for scoring rules).

formaldehyde) scored above 50% for both Screening Utility and Surveillance Utility. Eight additional standards scored above 50% only for Screening Utility.

DISCUSSION

OSHA has issued over 400 standards governing exposure to workplace chemicals since the Act was legislated in 1970. Most consist simply of permissible exposure limits (PEL) specifying airborne concentrations of employee exposure which may not be exceeded. There are no medical requirements accompanying this large group of standards. Only 21 standards over this 23-year period have included medical provisions.

On the surface many of the 21 medical provisions appear similarly structured, typically including a statement defining employee eligibility, a schedule for physical examinations, a list of medical examinations and tests, specifications for the physician's written opinion, requirements for the contents and storage of medical records, rules governing access to medical records, and a statement that examinations be performed by or under the supervision of a licensed physician. However, analysis of Total scores suggests substantial differences among standards and when the program elements are reviewed in more detail it is apparent that there are enormous variations and inconsistencies among them.

The medical provisions differ from each other in two ways. First they differ in their degree of completeness; some standards simply do not include some of the provisions found in others. For example, most of the 21 standards include a requirement for physical examinations, but the coke oven standard requires no physical examination other than a skin exam and the cotton dust standard requires no physical examination at all. While many agents are unique enough to warrant specific examinations, there are no obviously unique properties of these two exposures which would justify such differences in program design. As another example, five standards (benzene, cadmium, formaldehyde, lead, and methylenedianiline) have requirements for medical removal from exposure with protection for the earnings, seniority, and other employment rights and benefits of workers who are transferred; all other stan-

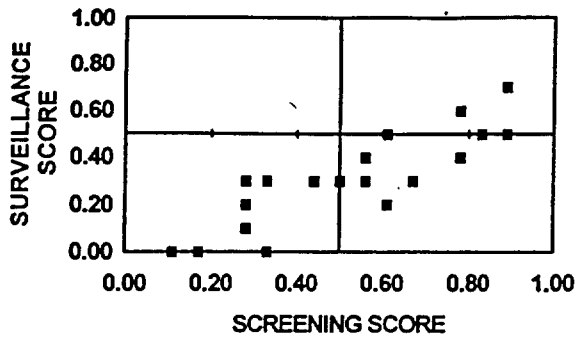

Fig. 3. Utility of medical provisions in 21 OSHA standards (see Table II and text for scoring rules).

dards fail to address this area. The cadmium standard has a unique provision not found in any other standard. Under the cadmium standard any abnormal biological monitoring result or other laboratory or clinical finding consistent with toxicity triggers a requirement that the employer reassess employee exposures, work practices, personal hygiene and engineering controls, and that any deficiencies identified be corrected.

The standards differ from one another in a second way. Among those standards which include a particular program element there is immense inconsistency in the actual substance of the requirements. For example, with regard to employee coverage all those who are exposed to acrylonitrile at or above the action level are covered by the medical program. For arsenic, however, employees are covered only if they are exposed above the action level for at least 30 days per year without regard to respirators. Those exposed to benzene are covered only if exposed above the action level for at least 30 days a year or above the PEL at least 10 days a year. For the substances included in the carcinogen standard, employees are covered if assigned to enter a regulated area regardless of specific exposures.

As another example, the acrylonitrile standard has no requirement at all for the collection of employee occupational histories. The arsenic standard requires that a work history be taken but does not specify what should be included. The benzene standard requires collection of a work history and specifies that specific attention be paid to prior exposures to benzene or other hematologic toxicants. The cotton dust standard not only requires a work history with specific attention to past cotton dust exposures but it also requires that a mandatory questionnaire with specific work history questions be filled out for each covered employee.

With a few exceptions, most notably the requirements for biologic monitoring or other laboratory tests, these differences among standards in the content of medical provisions bear no clear relationship to differences in the toxic properties of the regulated chemicals or their health effects.

Given such large and seemingly irrational differences in the specified content of these standards it might be hoped that there would be performance benchmarks which would ensure some measure of consistency and quality as a tradeoff for the leeway given to employers and their designated health providers in establishing specific program elements. The analysis of Quality Control scores, however, suggests that

this is not the case. No standard exceeded 64% of the possible quality control points. Most of the standards allow the health care providers great discretion in choosing examinations and tests, interpreting the results, and acting upon them. However only seven of the standards require these professionals to have more specific credentials than the possession of a medical degree and only three standards require the professionals to have had even minimal training related to the regulated chemicals or the tests and procedures. Given this lack of control over professional credentials and background it might still be possible to build in safeguards for clinical reliability and consistency by establishing protocols for exams and procedures or clear guidelines for the interpretation of results. Yet only five of the standards provide more than extremely minimal procedural protocols or interpretive guidelines. In addition, this body of regulations is almost silent on such other quality control measures as laboratory certification or criteria for adequate facilities and equipment.

The analysis of Screening and Surveillance Utility was undertaken in an effort to look at the overall design of the medical provisions. The goal was to determine whether this body of regulation has any coherent purpose or intent and whether such purpose makes sense in view of the overall mandate of the Occupational Safety and Health Act to secure healthy and safe places of employment. In other words, are the medical provisions of OSHA standards designed to contribute to population based primary prevention objectives, are they designed for secondary prevention and individual based diagnosis and treatment, or do they serve a more comprehensive, dual purpose?

Medical programs designed to contribute to primary prevention (the identification and control of health hazards at their source) would be expected to rate high in surveillance characteristics insofar as surveillance entails analysis of trends and distributions in order to initiate intervention. Such programs oriented to primary prevention might also, but not necessarily, rate high in screening characteristics which reflect attention to clinical care of individuals. On the other hand a medical program which failed to contribute to surveillance and primary prevention might still rate high in screening characteristics.

As stated by Millar [1986], "screening and monitoring, in and of themselves, prevent nothing; only the appropriate intervention, in response to results of these tests, can prevent . . . occupational disease and injuries." There are two general ways that individual results might serve prevention objectives. First, data might be combined in a search for trends and distributions which would help to identify risks at the earliest possible time. For example, a longitudinal decline in lung function among a group of workers exposed to isocyanates compared with an unexposed group might reveal a preventable hazard even before any individuals become symptomatically ill. Second, a single abnormality might be a sentinel indicator of a larger reservoir of workers at risk who have not yet come to clinical attention. For example, a single isocyanate exposed worker with asthma might, if traced back to the jobsite, lead to an entire department where ventilation controls have failed.

The results (Fig. 3) demonstrate that very few OSHA standards have added features to the traditional packaging of clinical occupational medical services which might make them more powerful as surveillance tools. Such features might include a requirement that physicians analyze data from screening programs to determine rates and distributions which might be associated with exposures or a requirement that health care providers visit the job site to investigate the possible relationship between

clinical findings and environmental risks. There is little evidence that the OSHA standard medical provisions have been constructed with such intentions in mind. In fact only the cadmium standard makes the explicit link between clinical results and environmental control with its requirement that employers reassess the workplace and implement necessary changes whenever there is an abnormal result from the medical program. A couple of other standards brush the surveillance issues lightly (e.g., the cotton dust, formaldehyde, and hearing conservation standards require or suggest longitudinal analysis of results for individuals with comparisons to baselines).

CONCLUSIONS

To achieve their potential for clinical and public health utility the medical portions of OSHA standards should be strengthened in four ways.

First, omissions and inconsistencies in the existing standards need to be resolved. The overall structure for medical services should be standardized, with allowance for substance specific modifications as appropriate, so the provider could be comfortable that the same framework for eligibility, medical and occupational histories, physical examinations, record keeping, medical removal, and counseling would apply regardless of the specific exposure.

Second, a uniform set of quality control measures should be specified in order to provide better assurance that services achieve minimum levels of excellence for all covered employees. Such measures would include appropriate credentials and training for providers, laboratory certification criteria, requirements for facilities and equipment, protocols for various examinations, and tests and interpretive guidelines.

Third, surveillance measures should be incorporated into medical service programs so that individual clinical results are used together with population and environmental data in an effort to identify and control workplace causes of disease and injury. These measures would include requirements that epidemiologic methods be applied to aggregate clinical data, that health care providers visit job sites and share information with labor-management health and safety committees, and that employers respond to surveillance findings with appropriate environmental interventions to prevent future illness.

Medical programs, even comprehensive ones with surveillance characteristics, cannot by themselves succeed in identifying and controlling hazards. For example, in the absence of exposure data from jobs held by exposed workers there are limits to the power of medical surveillance to identify exposure-health associations. Health care providers who want to provide more than individual clinical care should expect to work as part of an interdisciplinary team with others who have skills related to environmental assessment and control such as industrial hygienists, toxicologists, process and facility engineers, safety managers, and union representatives. Health professionals who are successful in applying their medical skills in such an organizational environment are more likely to succeed in prevention and less likely to be marginalized as providers of narrowly construed and technically oriented clinical services.

Fourth, a more efficient regulatory strategy is needed. For the past 20 years, the typical mode of setting workplace health and safety standards, including their embedded medical provisions, has been to address one substance at a time. This is the equivalent of salting one's food a single grain at a time and is ultimately both

exhausting and ineffective. A trivially small number of comprehensive health standards have been established since the Occupational Safety and Health Act was passed in 1970. A more powerful strategy would be to adopt generic standards which cover multiple substances simultaneously. An effective example of this generic approach is OSHA's Hazard Communication Standard (29 CFR 1910.1200) which applies a uniform set of requirements for safety data sheets, labeling, and employee training to thousands of chemicals. Another is OSHA's generic rule on Access to Employee Exposure and Medical Records (29 CFR 1910.20) which sets procedures for requesting and providing various records regardless of which chemical exposures were involved.

A similar generic approach should be utilized to establish a basic package of medical services which employers would be required to provide to employees exposed or potentially exposed to hazardous substances or conditions. OSHA was moving in this direction when it published an Advanced Notice of Proposed Rule making in the Federal Register on September 27, 1988 seeking public comments on the feasibility and usefulness of a generic medical program regulation. Shortly thereafter, this initiative went into regulatory hibernation, but it is still a timely notion. An effective design for such a standard would include an organizational and substantive framework for occupational medical services addressing five areas: medical and biological monitoring, record keeping, quality assurance, surveillance/prevention, and worker protection. Table III lists proposed elements of a generic occupational medical surveillance standard.

Many hazardous agents are reasonably unique and might be suitable for targeted tests and physical examinations. An effective medical surveillance program should therefore match specific medical tests and examinations to specific chemicals. This could be left to the discretion of employers and their designated health care providers. However, even with some control over credentials and training of eligible providers, this approach would inevitably lead to inconsistent services provided to different workers exposed to the same hazards. Another approach would be to require that employers rely upon a credible, authoritative occupational health organization such as NIOSH to identify a minimum package of examinations and tests linked to specific exposures. Some have suggested that such a matrix listing of chemicals (or chemical groups such as solvents or neurotoxicants) along with appropriate tests and examinations for each one be written directly into a generic medical surveillance standard. However, the effort to do this would turn an ostensibly generic rule making process into a tedious, de facto substance by substance exercise which would prove impractical. Also, this listing would become quickly outdated with advances in medical science, yet every change would require formal new rule making. For example, recent study results [LaMontagne et al., 1993] question the utility of the leukocyte differential as part of routine medical surveillance for workers exposed to ethylene oxide as required in the current OSHA standard. Once the specific test has been written into the standard, however, there is no rapid and administratively efficient way to adapt to new scientific knowledge. It would be more effective for a generic standard to reference an officially designated list developed by NIOSH with the provision that employers automatically update their medical programs whenever the list is formally revised.

In summary, OSHA's medical service requirements lack both consistency and coherence. Provisions vary tremendously among the 21 standards which have medical

TABLE III. Elements of a Generic Occupational Medical Surveillance Standard

I. Medical services
- A. Employee eligibility: linked to exposure level, likelihood of exposure, or symptoms
- B. Frequency and timing of examinations
- C. Specific examinations and tests: referenced to matrix prepared by NIOSH or other authoritative organizations and updated periodically
- D. Standardized occupational and medical history
- E. Medical management protocols: referenced to documents prepared by NIOSH or other authoritative organizations and updated periodically

II. Medical records
- A. Content of records
- B. Reports to employers and employees, including physician's written opinion
- C. Access and confidentiality
- D. Storage

III. Quality assurance
- A. Laboratory certification and proficiency testing
- B. Provider credentials, training, and experience
- C. Criteria for equipment and facilities
- D. Test and examination protocols

IV. Surveillance and prevention
- A. Aggregate data analysis
- B. Sentinel event analysis
- C. Health provider observation of work site and jobs
- D. Environmental evaluation and intervention linked to medical findings
- E. Employer and employee notification and education

V. Worker protection
- A. Medical removal criteria
- B. Medical removal protection benefits
- C. Multiple physician review

requirements. This lack presents abundant organizational obstacles to even the most conscientious employers, employees, and health care providers who are seeking to comply with the law and may have to design substantially different programs for workers exposed to different substances. For those who successfully determine which workers are eligible for which services, and who successfully identify and keep track of the differences in nuance in record keeping, history taking, and examination protocols among the various standards, there are additional regulatory weaknesses which limit the effectiveness of these programs as tools for both screening and surveillance. This paper has explored two of these weaknesses, the lack of quality control measures and the lack of surveillance features. The proposed method for improvement is the development of a generic occupational medical surveillance standard which would address these current shortcomings in a single, comprehensive rule.

NOTE ADDED IN PROOF

This article was written and accepted for publication prior to the date that the author began work for the Occupational Safety and Health Administration (OSHA). The views are that of the author.

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Twenty-one Occupational Safety and Health Act (OSHA) standards were identified which contain medical service provisions intended to help in the identification and control of harmful health effects of workplace exposures. The utility and effectiveness of these provisions have not previously been evaluated. All 21 standards were reviewed and assigned numerical scores for each of 24 potential medical program elements. Several of these elements were combined to calculate Quality Control, Screening Utility, and Surveillance Utility scores for each standard. Total scores varied greatly, suggesting a lack of consistency and uniformity which was even more obvious when the actual regulatory language was examined. The mean Quality score was only 26% of potential points. Seventeen of 21 standards received less than half the total possible Quality score. When arrayed on a two by two matrix only two standards scored above 50% for both Screening and Surveillance Utility. It was concluded that the medical service provisions in OSHA standards are lacking in consistency and coherence. Two major shortcomings are the lack of quality control elements and the absence of surveillance features which would permit medical program results to be utilized for prevention activities including the identification and control of workplace hazards. A generic occupational medical surveillance standard could address these current weaknesses. Elements of such a generic standard are proposed.

Key words: screening, surveillance, OSHA standards, occupational health, medical monitoring, prevention

INTRODUCTION

The Occupational Safety and Health Act of 1970 [29 United States Code (U.S.C.) 651 et seq.] authorizes the Secretary of Labor to set any standard for workplace exposure to hazardous chemicals and physical agents which "most adequately assures, to the extent feasible, on the basis of the best available evidence, that no employee will suffer material impairment of health or functional capacity even if such employee has regular exposure to the hazard dealt with by such standard for the

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F/generic medical surveillance

TABLE I. 21 OSHA Standards, Scoring of Medical Provisions

Standard, name	Standard, number	Total score	Quality score	Screening score	Surveillance score
Acrylonitrile	29 CFR 1910.1045	.46	.29	.67	.20
Arsenic, inorganic	29 CFR 1910.1018	.48	.21	.75	.40
Asbestos	29 CFR 1910.1001	.52	.36	.83	.30
Benzene	29 CFR 1910.1028	.67	.64	.92	.50
Bloodborne pathogens	29 CFR 1910.1030	.33	.14	.50	.00
Cadmium	29 CFR 1910.1027	.77	.64	.92	.70
Carcinogens[a]	29 CFR 1910.1003 to 1016	.25	.00	.50	.30
Coke ovens	29 CFR 1910.1029	.40	.14	.75	.30
Cotton dust	29 CFR 1910.1043	.56	.64	.75	.50
Dibromochloropropane	29 CFR 1910.1044	.42	.21	.75	.30
Ethylene oxide	29 CFR 1910.1047	.44	.14	.75	.30
Field sanitation	29 CFR 1910.142	.04	.07	.08	.00
Fire protection	29 CFR 1910.156	.08	.07	.08	.00
Formaldehyde	29 CFR 1910.1048	.56	.14	.92	.60
Hazardous waste operations	29 CFR 1910.120	.40	.14	.67	.30
Hearing conservation	29 CFR 1910.95	.38	.43	.33	.30
Lead	29 CFR 1910.1025	.67	.64	.92	.50
Laboratories	29 CFR 1910.1450	.17	.07	.42	.10
Methylenedianiline	29 CFR 1910.1050	.52	.14	.92	.40
Respirator program	29 CFR 1910.134	.15	.07	.42	.20
Vinyl chloride	29 CFR 1910.1017	.40	.14	.75	.40
	Mean	.41	.26	.65	.31
	Standard deviation	.22	.20	.30	.21

[a]OSHA carcinogen standard covers 4-Nitrobiphenyl, α-Naphthylamine, methyl chloromethyl ether, 3,3′-Dichlorobenzidine and its salts, bis-Chloromethyl ether, β-Naphthylamine, Benzidine, 4-Aminodiphenyl, Ethyleneimine, β-Propiolactone, 2-Acetylaminofluorene, 4-Dimethylaminoazobenzene, N-Nitrosodimethylamine.

period of his working life" [Occupational Safety and Health Act Section 6(b)(5)]. In addition to establishing requirements for permissible exposure limits, engineering controls, work practices, and personal protective equipment, "where appropriate, any such standard shall prescribe the type and frequency of medical examinations or other tests which shall be made available, by the employer or at his cost, to employees exposed to such hazards in order to most effectively determine whether the health of such employees is adversely affected by such exposure" [Occupational Safety and Health Act Section 6(b)(7)].

Since 1970 the Occupational Safety and Health Administration (OSHA) has published 21 standards which include provisions for medical examinations and related tests (Table I). There has been no systematic consideration of the content or utility of these medical regulations. One recent paper reported on the enforcement of medical requirements in the lead, ethylene oxide, and formaldehyde standards [Schwartz et al., 1992]. Two papers have reviewed the content and implementation of medical requirements in the hazardous waste operations and emergency response standard [Melius, 1990; Udasin et al., 1991].

The analysis in this paper utilizes a distinction made previously [Silverstein, 1990] between two concepts which are frequently but incorrectly used interchangeably: screening and surveillance. Screening is the application of clinical procedures to

members of a group, often chosen to be asymptomatic but at high risk, for the purpose of identifying those needing further individual attention. The National Institute for Occupational Safety and Health (NIOSH) considers the purpose of screening to be "detecting organ dysfunction or disease before an individual would normally seek medical care" [Halperin et al., 1986]. Screening is inherently a tool for secondary prevention, the early diagnosis, and treatment of disease. Its focus is on individuals in a population.

Surveillance, which has been described as "the ascertainment of information for the purpose of detecting changes in trend or distribution in order to initiate intervention, control or other investigation" [Last, 1986], focuses on the population itself. It "means the continued watchfulness over the distribution and trends of incidence . . ." [Langmuir, 1963]. Surveillance starts with the collection of information about individuals and then aggregates this information in order to examine patterns within a population. It is essentially a tool for primary prevention, the identification and elimination of the causes of disease.

Some tests may be better suited to either screening or surveillance than to the other. For example, a surveillance program which uses a medical test to distinguish a workplace with a high rate of health effects from one with a lower rate may be successful even if the test yields so many false negative results that it has limited utility for satisfying the clinical needs of individuals. Other tests may be useful for both screening and surveillance, depending upon how the results are actually used. A physician, for example, who uses lung function testing on a population to identify individual patients in need of counseling and treatment has derived screening value from the tests. These screening results, however, can only serve a surveillance function if the physician uncouples the information from the individual patients and evaluates patterns of findings within the group (aggregate analysis) or makes an attempt to link the results with some feature of the environment which may affect additional people (sentinel event analysis).

A major premise of this paper is that medical and biological monitoring of workers can serve a narrow, clinically oriented secondary prevention purpose (screening) or can contribute to a broader, public health oriented primary prevention strategy (surveillance), depending upon the manner in which the medical services are organized and used. A numeric scoring scheme developed for this analysis was used to examine how the existing OSHA medical service provisions are actually designed to perform.

MATERIALS AND METHODS

All OSHA standards promulgated since 1970 were examined and 21 were identified which contained requirements for employee medical evaluations, examinations, or tests. The OSHA carcinogen standard (29 Code of Federal Regulations [CFR] 1910.1003 to 1910.16) covers 13 different chemical carcinogens with virtually identical provisions and was counted only once.

Twenty-four potential features of a comprehensive medical program were defined. These included elements associated with medical examinations and tests (e.g., examination schedule, elements of occupational history), record keeping (e.g., access to records, confidentiality), quality control (e.g., laboratory certification, provider credentials), and management of results (e.g., medical removal provisions, fitness to

TABLE II. Scoring Rules for Medical Program Elements in OSHA Standards*

Program element	Score = 0	Score = 1	Score = 2
1. Physical examination	None	Required, but nonspecific	Required, with specific elements
2. Medical history	None	Required, but nonspecific	Required, with specific elements
3. Occupational history	None	Required, but nonspecific	Required, with specific elements
4. Laboratory tests	None	Required, but nonspecific	Required, with specific elements
5. Examination schedule	Baseline only or emergency/ complaint only	Baseline + periodic	Baseline + periodic + emergency/complaint
6. Eligibility	Nonspecific	Linked to qualitative exposure assessment	Linked to quantitative exposure assessment
7. Provider credentials	None	Professional degree specified	Degree + specialized training or experience
8. Laboratory certification	None	Certification required	Certification + proficiency testing
9. Guidelines for interpretation of results	None	Minimal	Comprehensive
10. Test result norms for comparison	None	Norms specified	Norms specified + required comparisons with baseline
11. Guidelines for treatment or care	None	Minimal	Comprehensive
12. Facilities and equipment	None	Minimal specifications	Comprehensive specifications
13. Provider training: standard specific	None	Minimal	Comprehensive
14. Protocols for examinations and tests	None	Minimal	Comprehensive
15. Employee records: contents	None	To include tests or exams or other material	To include tests, exams, and other material
16. Employee records: confidentiality and privacy	None	Limits on information about nonoccupational conditions	Explicit protections for confidentiality and privacy
17. Physician written opinions	None	Required, but nonspecific	Required, with specific elements
18. Employee records: preservation and storage	Less stringent or specific than 29 CFR 1910.20	Equivalent to 29 CFR 1910.20	Exceeds 29 CFR 1910.20
19. Access to medical records	Less stringent or specific than 29 CFR 1910.20	Equivalent to 29 CFR 1910.20	Exceeds 29 CFR 1910.20
20. Fitness to work recommendations	None required	Required, but nonspecific	Required, with specific guidelines
21. Counseling and referrals	None	Provision of results required, but without specific guidelines	Provisions of results + specific guidelines for counseling or referrals
22. Medical removal provisions	None	Medical removal requirements specified	Medical removal requirements + medical removal protection benefits
23. Epidemiology	None	Aggregate data description required	Aggregate data analysis required
24. Environmental intervention	None	Provider walkthrough or inspection required	Workplace evaluations or changes required

*29 CFR 1910.20: OSHA rule on access to employee exposure and medical records. Program elements included in Quality Control score: nos. 7, 8, 9, 11, 12, 13, 14; program elements included in Screening Utility score: nos. 1, 2, 3, 4, 9, 11, 20, 21, 22; program elements included in Surveillance Utility score: nos. 3, 5, 10, 23, 24.

work determinations). Each standard was scored on a three-level scale (0,1,2) for each of these 24 program elements. The complete listing of program elements with scoring criteria is presented in Table II.

Seven of the 24 program elements were combined to generate a Quality Control score for each standard, based on a judgment about which elements were most necessary to assure uniformity, consistency, and attainment of professional standards in the delivery of services. These elements include:

1. No. 7: provider credentials, including professional degrees and specialty training or experience;
2. No. 8: laboratory certification, including proficiency testing;
3. No. 9: guidelines for interpreting the results of tests and examinations. For example, the asbestos standard requires that chest x-rays be interpreted in accordance with a professionally accepted classification system and that comparisons be made with a set of reference radiographs.
4. No. 11: Guidelines or protocols for the appropriate follow up of positive findings, including any additional required testing, examinations, or protective measures.
5. No. 12: Specifications for facilities and equipment. For example, the cotton dust standard requires that spirometers meet criteria for accuracy, volume capacity, and other operating characteristics.
6. No. 13: Provider training specific to the requirements of the standard. For example, the benzene standard requires that pulmonary function testing be performed by a person who has completed a training course in spirometry.
7. No. 14: Protocols for conducting examinations and tests, such as the specifications in the benzene standard for peripheral blood smear procedures.

Nine program elements were combined to generate a Screening Utility score, based on a judgment about which elements were most necessary to assure the generation and use of information relevant to the delivery of individual clinical services. These elements include:

1. No. 1: Requirements for physical examination, including specificity and extent.
2. No. 2: Requirements for medical history, including specificity and extent.
3. No. 3: Requirements for occupational history, including specificity and extent.
4. No. 4: Laboratory test requirements, including either unspecified testing or a required battery of tests.
5. No. 9: Guidelines for the interpretation of test and examination results.
6. No. 11: Guidelines for the treatment or care of employees with abnormal results.
7. No. 20: Requirements that the physician make a judgment about an employee's fitness for work, including the need for special protection or removal.
8. No. 21: Requirements for providing employees with results of examinations, including guidelines for counseling or referring employees for further evaluation.

Six other program elements were combined to generate a Surveillance Utility score, based on a judgment about which elements were most necessary to assure the evaluation of aggregate or sentinel data and the application of these data to prevention interventions. These elements include:

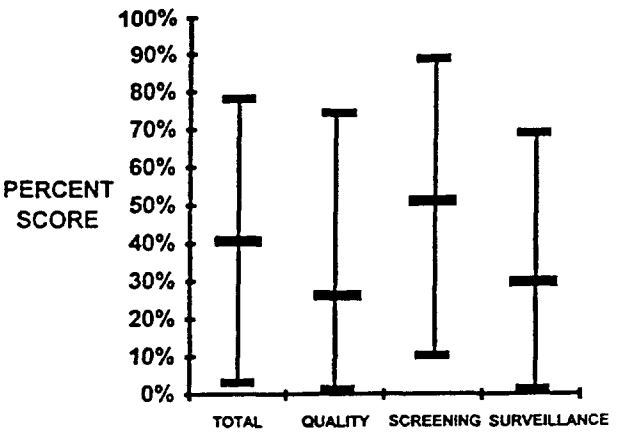

Fig. 1. Mean scores and ranges for medical provisions in 21 OSHA standards (see Table I for individual scores).

1. No. 3: Requirements for occupational history, including specificity and extent.
2. No. 5: Examination schedule, including baseline and periodic evaluation.
3. No. 10: Requirements for comparing test results with normative levels and with baseline results.
4. No. 23: Requirements for aggregate data description or analysis.
5. No. 24: Requirements for environmental evaluation or intervention in response to examination and test results.

RESULTS

Each of the 21 standards received a Total, Quality Control, Screening Utility, and Surveillance Utility score expressed as the percentage of the highest potential score for that particular index (Table I). Mean scores and ranges for the four scoring indices are presented in Figure 1. Total scores ranged from 77% of the maximum possible for the cadmium standard to 4% for the field sanitation standard with a mean score of 41%. Fourteen of the 21 standards analyzed received less than half the total possible score. Scores on the Quality index ranged from a high of 64%, shared by the benzene, cadmium, cotton dust, and lead standards, to a low of zero for the carcinogens standard. The mean Quality score was 26%; 17 of the 21 standards received less than half the total possible Quality points.

Screening Utility scores varied from 89% (cadmium and lead) to 11% (field sanitation) with a mean of 52%. Surveillance Utility scores varied from 70% (cadmium) to zero (bloodborne pathogens, field sanitation, and fire protection) with a mean of 31%. The mean scores for Screening Utility and Surveillance Utility differed significantly from each other ($p < .01$, t-test).

The relationship between Screening Utility and Surveillance Utility scores was examined by plotting the two scores for each standard on a two-dimensional matrix (Figs. 2, 3). Four quadrants were defined according to whether scores were above or below the 50% level for each of the two indices. Only two standards (cadmium and

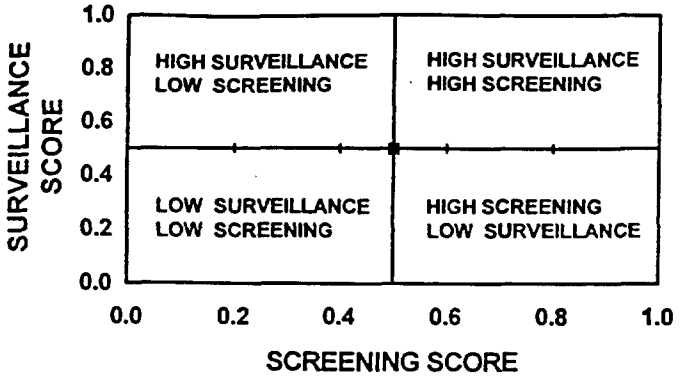

Fig. 2. Utility of medical programs (see Table II and text for scoring rules).

formaldehyde) scored above 50% for both Screening Utility and Surveillance Utility. Eight additional standards scored above 50% only for Screening Utility.

DISCUSSION

OSHA has issued over 400 standards governing exposure to workplace chemicals since the Act was legislated in 1970. Most consist simply of permissible exposure limits (PEL) specifying airborne concentrations of employee exposure which may not be exceeded. There are no medical requirements accompanying this large group of standards. Only 21 standards over this 23-year period have included medical provisions.

On the surface many of the 21 medical provisions appear similarly structured, typically including a statement defining employee eligibility, a schedule for physical examinations, a list of medical examinations and tests, specifications for the physician's written opinion, requirements for the contents and storage of medical records, rules governing access to medical records, and a statement that examinations be performed by or under the supervision of a licensed physician. However, analysis of Total scores suggests substantial differences among standards and when the program elements are reviewed in more detail it is apparent that there are enormous variations and inconsistencies among them.

The medical provisions differ from each other in two ways. First they differ in their degree of completeness; some standards simply do not include some of the provisions found in others. For example, most of the 21 standards include a requirement for physical examinations, but the coke oven standard requires no physical examination other than a skin exam and the cotton dust standard requires no physical examination at all. While many agents are unique enough to warrant specific examinations, there are no obviously unique properties of these two exposures which would justify such differences in program design. As another example, five standards (benzene, cadmium, formaldehyde, lead, and methylenedianiline) have requirements for medical removal from exposure with protection for the earnings, seniority, and other employment rights and benefits of workers who are transferred; all other stan-

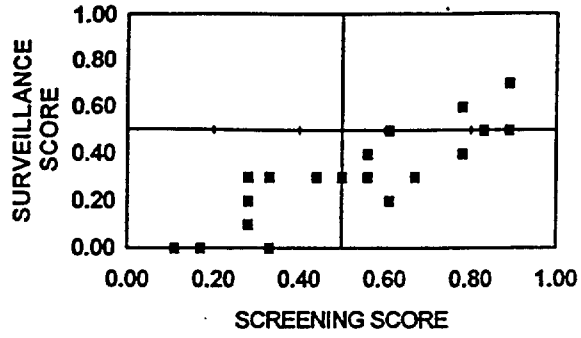

Fig. 3. Utility of medical provisions in 21 OSHA standards (see Table II and text for scoring rules).

dards fail to address this area. The cadmium standard has a unique provision not found in any other standard. Under the cadmium standard any abnormal biological monitoring result or other laboratory or clinical finding consistent with toxicity triggers a requirement that the employer reassess employee exposures, work practices, personal hygiene and engineering controls, and that any deficiencies identified be corrected.

The standards differ from one another in a second way. Among those standards which include a particular program element there is immense inconsistency in the actual substance of the requirements. For example, with regard to employee coverage all those who are exposed to acrylonitrile at or above the action level are covered by the medical program. For arsenic, however, employees are covered only if they are exposed above the action level for at least 30 days per year without regard to respirators. Those exposed to benzene are covered only if exposed above the action level for at least 30 days a year or above the PEL at least 10 days a year. For the substances included in the carcinogen standard, employees are covered if assigned to enter a regulated area regardless of specific exposures.

As another example, the acrylonitrile standard has no requirement at all for the collection of employee occupational histories. The arsenic standard requires that a work history be taken but does not specify what should be included. The benzene standard requires collection of a work history and specifies that specific attention be paid to prior exposures to benzene or other hematologic toxicants. The cotton dust standard not only requires a work history with specific attention to past cotton dust exposures but it also requires that a mandatory questionnaire with specific work history questions be filled out for each covered employee.

With a few exceptions, most notably the requirements for biologic monitoring or other laboratory tests, these differences among standards in the content of medical provisions bear no clear relationship to differences in the toxic properties of the regulated chemicals or their health effects.

Given such large and seemingly irrational differences in the specified content of these standards it might be hoped that there would be performance benchmarks which would ensure some measure of consistency and quality as a tradeoff for the leeway given to employers and their designated health providers in establishing specific program elements. The analysis of Quality Control scores, however, suggests that

this is not the case. No standard exceeded 64% of the possible quality control points. Most of the standards allow the health care providers great discretion in choosing examinations and tests, interpreting the results, and acting upon them. However only seven of the standards require these professionals to have more specific credentials than the possession of a medical degree and only three standards require the professionals to have had even minimal training related to the regulated chemicals or the tests and procedures. Given this lack of control over professional credentials and background it might still be possible to build in safeguards for clinical reliability and consistency by establishing protocols for exams and procedures or clear guidelines for the interpretation of results. Yet only five of the standards provide more than extremely minimal procedural protocols or interpretive guidelines. In addition, this body of regulations is almost silent on such other quality control measures as laboratory certification or criteria for adequate facilities and equipment.

The analysis of Screening and Surveillance Utility was undertaken in an effort to look at the overall design of the medical provisions. The goal was to determine whether this body of regulation has any coherent purpose or intent and whether such purpose makes sense in view of the overall mandate of the Occupational Safety and Health Act to secure healthy and safe places of employment. In other words, are the medical provisions of OSHA standards designed to contribute to population based primary prevention objectives, are they designed for secondary prevention and individual based diagnosis and treatment, or do they serve a more comprehensive, dual purpose?

Medical programs designed to contribute to primary prevention (the identification and control of health hazards at their source) would be expected to rate high in surveillance characteristics insofar as surveillance entails analysis of trends and distributions in order to initiate intervention. Such programs oriented to primary prevention might also, but not necessarily, rate high in screening characteristics which reflect attention to clinical care of individuals. On the other hand a medical program which failed to contribute to surveillance and primary prevention might still rate high in screening characteristics.

As stated by Millar [1986], "screening and monitoring, in and of themselves, prevent nothing; only the appropriate intervention, in response to results of these tests, can prevent . . . occupational disease and injuries." There are two general ways that individual results might serve prevention objectives. First, data might be combined in a search for trends and distributions which would help to identify risks at the earliest possible time. For example, a longitudinal decline in lung function among a group of workers exposed to isocyanates compared with an unexposed group might reveal a preventable hazard even before any individuals become symptomatically ill. Second, a single abnormality might be a sentinel indicator of a larger reservoir of workers at risk who have not yet come to clinical attention. For example, a single isocyanate exposed worker with asthma might, if traced back to the jobsite, lead to an entire department where ventilation controls have failed.

The results (Fig. 3) demonstrate that very few OSHA standards have added features to the traditional packaging of clinical occupational medical services which might make them more powerful as surveillance tools. Such features might include a requirement that physicians analyze data from screening programs to determine rates and distributions which might be associated with exposures or a requirement that health care providers visit the job site to investigate the possible relationship between

clinical findings and environmental risks. There is little evidence that the OSHA standard medical provisions have been constructed with such intentions in mind. In fact only the cadmium standard makes the explicit link between clinical results and environmental control with its requirement that employers reassess the workplace and implement necessary changes whenever there is an abnormal result from the medical program. A couple of other standards brush the surveillance issues lightly (e.g., the cotton dust, formaldehyde, and hearing conservation standards require or suggest longitudinal analysis of results for individuals with comparisons to baselines).

CONCLUSIONS

To achieve their potential for clinical and public health utility the medical portions of OSHA standards should be strengthened in four ways.

First, omissions and inconsistencies in the existing standards need to be resolved. The overall structure for medical services should be standardized, with allowance for substance specific modifications as appropriate, so the provider could be comfortable that the same framework for eligibility, medical and occupational histories, physical examinations, record keeping, medical removal, and counseling would apply regardless of the specific exposure.

Second, a uniform set of quality control measures should be specified in order to provide better assurance that services achieve minimum levels of excellence for all covered employees. Such measures would include appropriate credentials and training for providers, laboratory certification criteria, requirements for facilities and equipment, protocols for various examinations, and tests and interpretive guidelines.

Third, surveillance measures should be incorporated into medical service programs so that individual clinical results are used together with population and environmental data in an effort to identify and control workplace causes of disease and injury. These measures would include requirements that epidemiologic methods be applied to aggregate clinical data, that health care providers visit job sites and share information with labor-management health and safety committees, and that employers respond to surveillance findings with appropriate environmental interventions to prevent future illness.

Medical programs, even comprehensive ones with surveillance characteristics, cannot by themselves succeed in identifying and controlling hazards. For example, in the absence of exposure data from jobs held by exposed workers there are limits to the power of medical surveillance to identify exposure-health associations. Health care providers who want to provide more than individual clinical care should expect to work as part of an interdisciplinary team with others who have skills related to environmental assessment and control such as industrial hygienists, toxicologists, process and facility engineers, safety managers, and union representatives. Health professionals who are successful in applying their medical skills in such an organizational environment are more likely to succeed in prevention and less likely to be marginalized as providers of narrowly construed and technically oriented clinical services.

Fourth, a more efficient regulatory strategy is needed. For the past 20 years, the typical mode of setting workplace health and safety standards, including their embedded medical provisions, has been to address one substance at a time. This is the equivalent of salting one's food a single grain at a time and is ultimately both

exhausting and ineffective. A trivially small number of comprehensive health standards have been established since the Occupational Safety and Health Act was passed in 1970. A more powerful strategy would be to adopt generic standards which cover multiple substances simultaneously. An effective example of this generic approach is OSHA's Hazard Communication Standard (29 CFR 1910.1200) which applies a uniform set of requirements for safety data sheets, labeling, and employee training to thousands of chemicals. Another is OSHA's generic rule on Access to Employee Exposure and Medical Records (29 CFR 1910.20) which sets procedures for requesting and providing various records regardless of which chemical exposures were involved.

A similar generic approach should be utilized to establish a basic package of medical services which employers would be required to provide to employees exposed or potentially exposed to hazardous substances or conditions. OSHA was moving in this direction when it published an Advanced Notice of Proposed Rule making in the Federal Register on September 27, 1988 seeking public comments on the feasibility and usefulness of a generic medical program regulation. Shortly thereafter, this initiative went into regulatory hibernation, but it is still a timely notion. An effective design for such a standard would include an organizational and substantive framework for occupational medical services addressing five areas: medical and biological monitoring, record keeping, quality assurance, surveillance/prevention, and worker protection. Table III lists proposed elements of a generic occupational medical surveillance standard.

Many hazardous agents are reasonably unique and might be suitable for targeted tests and physical examinations. An effective medical surveillance program should therefore match specific medical tests and examinations to specific chemicals. This could be left to the discretion of employers and their designated health care providers. However, even with some control over credentials and training of eligible providers, this approach would inevitably lead to inconsistent services provided to different workers exposed to the same hazards. Another approach would be to require that employers rely upon a credible, authoritative occupational health organization such as NIOSH to identify a minimum package of examinations and tests linked to specific exposures. Some have suggested that such a matrix listing of chemicals (or chemical groups such as solvents or neurotoxicants) along with appropriate tests and examinations for each one be written directly into a generic medical surveillance standard. However, the effort to do this would turn an ostensibly generic rule making process into a tedious, de facto substance by substance exercise which would prove impractical. Also, this listing would become quickly outdated with advances in medical science, yet every change would require formal new rule making. For example, recent study results [LaMontagne et al., 1993] question the utility of the leukocyte differential as part of routine medical surveillance for workers exposed to ethylene oxide as required in the current OSHA standard. Once the specific test has been written into the standard, however, there is no rapid and administratively efficient way to adapt to new scientific knowledge. It would be more effective for a generic standard to reference an officially designated list developed by NIOSH with the provision that employers automatically update their medical programs whenever the list is formally revised.

In summary, OSHA's medical service requirements lack both consistency and coherence. Provisions vary tremendously among the 21 standards which have medical

TABLE III. Elements of a Generic Occupational Medical Surveillance Standard

I. Medical services
- A. Employee eligibility: linked to exposure level, likelihood of exposure, or symptoms
- B. Frequency and timing of examinations
- C. Specific examinations and tests: referenced to matrix prepared by NIOSH or other authoritative organizations and updated periodically
- D. Standardized occupational and medical history
- E. Medical management protocols: referenced to documents prepared by NIOSH or other authoritative organizations and updated periodically

II. Medical records
- A. Content of records
- B. Reports to employers and employees, including physician's written opinion
- C. Access and confidentiality
- D. Storage

III. Quality assurance
- A. Laboratory certification and proficiency testing
- B. Provider credentials, training, and experience
- C. Criteria for equipment and facilities
- D. Test and examination protocols

IV. Surveillance and prevention
- A. Aggregate data analysis
- B. Sentinel event analysis
- C. Health provider observation of work site and jobs
- D. Environmental evaluation and intervention linked to medical findings
- E. Employer and employee notification and education

V. Worker protection
- A. Medical removal criteria
- B. Medical removal protection benefits
- C. Multiple physician review

requirements. This lack presents abundant organizational obstacles to even the most conscientious employers, employees, and health care providers who are seeking to comply with the law and may have to design substantially different programs for workers exposed to different substances. For those who successfully determine which workers are eligible for which services, and who successfully identify and keep track of the differences in nuance in record keeping, history taking, and examination protocols among the various standards, there are additional regulatory weaknesses which limit the effectiveness of these programs as tools for both screening and surveillance. This paper has explored two of these weaknesses, the lack of quality control measures and the lack of surveillance features. The proposed method for improvement is the development of a generic occupational medical surveillance standard which would address these current shortcomings in a single, comprehensive rule.

NOTE ADDED IN PROOF

This article was written and accepted for publication prior to the date that the author began work for the Occupational Safety and Health Administration (OSHA). The views are that of the author.

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