Occupational Health Surveillance: A Means to Identify Work-Related Risks

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Abstract: The lack of successful disease surveillance methods has resulted in few reliable estimates of workplace-related disease. Hazard surveillance—the ongoing assessment of chemical use and worker exposure to the chemicals—is presented as a way to supplement occupational disease surveillance. Existing OSHA (Occupational Safety and Health Administration) and NIOSH (National Institute for Occupational Health) data systems are adapted to this function to characterize the distribution and type of hazardous industry in Los Angeles County. A new method is developed for ranking potentially hazardous industries in the county using actual exposure measurements from federal OSHA compliance inspections. The strengths of the different systems are presented along with considerations of industrial employment and types of specific chemical exposures. Applications for information from hazard surveillance are discussed in terms of intervention, monitoring exposure control, planning, research, and as a complement to disease surveillance. (*Am J Public Health* 1986; 76:1089–1096.)

Introduction

Occupational disease surveillance lacks specificity and timeliness, and is estimated to be "70 years behind [surveillance of] communicable disease."[1] As a result, few reliable workplace disease statistics exist. This is due in part to a lack of guidelines on how to recognize occupational disease,[2] and the fact that disease related to work is rarely unique to work exposures.[3,4] Moreover, few health professionals are well educated in diagnosing occupational disease when the association is not acute.

Various states have developed reporting requirements for selected diseases or have used workers' compensation and physicians' first reports for occupational disease surveillance. The usefulness of these systems has generally been restricted to acute illness. At the federal level, the Occupational Safety and Health Administration (OSHA) constructed a standardized scheme to monitor injuries and illnesses. While the injury monitoring system has functioned reasonably well, illness data have been described as unreliable and grossly underreported because of poor employee, employer, and physician awareness.[1,5]

The weaknesses in existing disease surveillance systems have been addressed in part by the National Institute for Occupational Safety and Health (NIOSH) which has made substantial progress in developing approaches to disease surveillance.[4] In addition to the ongoing NIOSH efforts, the Bureau of Labor Statistics recently held a major conference on new approaches to disease surveillance[6] and the National Academy of Sciences is currently conducting a study of surveillance methods.

These difficulties led us to investigate the complementary approach of hazard surveillance as a means of predicting work-related health problems. We define hazard surveillance as the ongoing assessment and evaluation of chemical use and worker exposure to those chemicals in industry. The first step in implementing hazard surveillance is the development of hazard profiles of various industries. A hazard profile consists of information on industry demographics (such as employment size) in a defined geographical area, use of chemicals in each workplace, levels to which workers are exposed, and data on the dose-response relationship for each chemical. Development of the profiles from these four elements provides the foundation for hazard surveillance programs.

Inattention to systems of hazard surveillance has occurred, in part, because of the historical focus on disease surveillance, but also because of the limited sources of data available for utilization in hazard surveillance. In theory, the optimum hazard surveillance program would have available information on the chemical identities and exposure levels for every worker in the United States. We have reviewed elsewhere the sources of information on hazards available to the health professional in California for establishing hazard surveillance programs.[7] That review found that there were virtually no hazard data available at the state and local level because the data either did not exist at all or did not exist in a form that was reasonably accessible. A few data sources at the federal level, however, appear potentially useful for surveillance purposes.

We have used these federal data sources to identify and evaluate chemical use and levels of worker exposure in order to develop profiles of potentially hazardous industries. A method for ranking hundreds of industry groups by chemical exposure is constructed and compared to existing methods for ranking industry. The methods are applied to a local setting by considering the industrial rankings in the context of employment patterns in Los Angeles County.

Methods

To rank and compare industries by their potential for having significant occupational health hazards, the following conditions were accepted:

- Rankings are for industry only, and not occupation.

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Glossary of Acronyms

IBER —Inspection Based Exposure Rankings
IRI —Industry Risk Index
MIS —OSHA Management Information System
MedSubIns —Median Severity Level weighted by Number of Substance Inspections
MedSubs —Median Severity Level weighted by Number of Substances
MnSubIns —Mean Severity Level weighted by Number of Substance Inspections
MnSubs —Mean Severity Level weighted by Number of Substances
NEC —Not elsewhere classified
NOHS —National Occupational Hazard Survey
OWI —OSHA Weighted Index
PEL —Permissible Exposure Level
RTECS —Registry of Toxic Effects of Chemical Substances
SIC —Standard Industrial Classification

- Industries are defined by their four-digit Standard Industrial Classification (SIC) code. Within a SIC, there are industries which may have different chemical usage and exposure experience.
- Psychological and physical factors were not considered.

To rank industries by their potential or real exposures to hazardous substances, three types of information were sought:

- What is the extent of exposure to hazardous chemicals in the industry, including the number of substances and levels of exposure?
- What is the severity of the health effects for each chemical?
- How many workers are exposed?

Data Sources

NIOSH's National Occupational Hazard Survey (NOHS),[8,9] conducted from 1972–74, identifies *potential* chemical exposures in industries. The NOHS compiled exhaustive lists of substances found in a systematic random sample of industries and estimated the number of workers exposed. No industrial hygiene measurements of exposure were made; the presence of the chemicals in an industry represented potential exposures only. To compensate for the lack of direct sampling, NOHS recorded whether exposure was subject to engineering controls or whether personal protective equipment was required, and whether potential exposure to workers was full-time or part-time.[9]

The federal OSHA Management Information System (MIS) inspection data files, on the other hand, include *actual* exposure levels from federal inspections and are the only substantial body of compiled data on workplace exposures. Exposure level by job title is available in this system.

Ranking Schemes

Two of the three measures used to rank industries are modifications of algorithms developed by NIOSH and OSHA, and rely on use of NOHS data. We developed a third method using OSHA inspection data that was based on the exposure information gathered by OSHA during inspections. This method ranks industry according to the average exposure levels found for highly hazardous chemicals in a particular SIC.

For a system prioritizing industry to be relevant in a particular geographical area, it must consider employment patterns. Therefore, a fourth resource utilized is employment size by SIC in Los Angeles County. For this purpose we obtained a commercially available tape listing all Los Angeles County employers by primary and secondary SIC along with the number of employees.

The NIOSH-based measure is the Industry Risk Index (IRI).[10] It uses information on every chemical found to be present within each SIC in both the National Occupational Hazard Survey (NOHS) and the Registry of Toxic Effects of Chemical Substances (RTECS).[11] The chemicals are rated on a potency scale using toxicological data and weighted by an estimate of how many workers are potentially exposed; the results are then summed for all chemicals in the SIC and the industries ranked. Over 1,700 chemicals are considered.

The second measure is the OSHA Weighted Index (OWI)[12] which uses the same NOHS data to estimate the number of workers exposed to a given substance but ranks only those 450 substances regulated by OSHA according to a simplified four-point toxicity scale constructed by a consensus panel.

Inspection Based Exposure Rankings

The third measure, Inspection Based Exposure Rankings (IBERs), was created specifically for this study. Federal OSHA inspection data for 1979–82 were used. The data derived from approximately 15,000 inspections and 60,000 industrial hygiene test samples from 475 SICs. Sixty-nine chemicals have greater than 100 test samples and constitute 91 per cent of all test samples. SICs with fewer than three inspections were eliminated from consideration. Although these OSHA data are the only source of actual exposure levels they have three potential limitations:

- In 1981 OSHA began to target large firms where previous inspections in the same SIC had documented high exposures to workers. As a result, fewer substances were sampled from a more narrow spectrum of industries.
- Industrial hygiene inspections are not random; they are often conducted in response to safety referrals and complaints. Therefore, some industries have been inspected more often than others.
- The data available on the computer tape obtained from OSHA did not contain exposure information from states with their own state plans. Important data from approximately 20 states, including several large industrial states such as California, Michigan and North Carolina, are missing from the data base. However, this limitation should be temporary because of the requirement that a state plan be "at least as effective" as the federal program. In the future, most, if not all, of the states will collect data similar to the federal MIS and that information should be centralized into the federal system.

For the purpose of ranking industries, a schematic method was developed to summarize the test sample data. There is one record for each time a substance was inspected, denoted as a "substance-inspection unit." We averaged the test samples for each substance in an inspection and divided that result by the substance's Permissible Exposure Level (PEL) to give a "severity level" for that substance-inspection unit. The severity levels for each substance found in a SIC were then combined for all substance-inspection units and both a mean and median value were calculated for the distribution. Both values are informative because the distribution of severity levels for each substance within an SIC is almost always highly skewed.

These values do not take into account either the varying number of substances or the varying number of inspections in a SIC. If used alone, they can be misleading, for obvious reasons. Therefore, four Inspection Based Exposure Ranking (IBER) measures were developed to account for both substances and substance inspections, as well as the mean and median severity levels. These four IBER variables are:

1. *MedSubs*—The median of the severity levels for all substance-inspection units multiplied by the number of unique substances sampled in the SIC.
2. *MedSubIns*—The median of the severity levels for all substance-inspection units multiplied by the number of substance inspections for the SIC.
3. *MnSubs*—The mean of the severity levels for all substance-inspection units multiplied by the number of unique substances sampled in the SIC.
4. *MnSubIns*—The mean of the severity levels for all substance-inspection units multiplied by the number of substance-inspections for the SIC.

Hazard Factor

A panel of scientists convened by OSHA ranked regulated chemicals by their degree of hazard according to a four-point (1, 3, 7, 10) scale (with 10 most toxic). This hazard weighting system was applied to the inspection data to weight the frequency of sampling, and the severity of the exposure by the degree of hazardousness.

Severity levels over 50 per cent of the PEL were substantially more common for hazards weighted 7 and 10 than for those ranked 1 and 3. Therefore, we decided to include only those substances weighted 7 or 10 to rank industry by the four IBER variables.

In order to use the IBERs to rank SICs, each of the four ranking components (MedSubs, MedSubIns, MnSubs, MnSubIns) was independently calculated and four lists of the most hazardous industries were developed. A composite list was constructed from the ranks of each IBER with the lowest total score ranking as #1 or most hazardous on the composite list (see Table 1 for the first 25).

Results

Rankings of industry by IRI, OWI, IBER, and employment were generated (see Tables 1 and 2). The rankings reflect the nature of the data bases from which they were derived. Industries ranking high in the IBER generally have documented high exposures to substances with recognized toxicity, e.g., lead, silica, asbestos, coal tar pitch volatiles, chromium, arsenic, and other metals, and a variety of organic solvents such as toluene, xylene, trichloroethylene, ethylene dichloride, trichloroethane, perchloroethylene, and carbon tetrachloride. Industries high on the IRI and OWI are those industries with large numbers of chemicals with marked toxicity, regardless of exposure levels.

Three approaches to prioritizing the exposure rankings were considered: by high employment in Los Angeles County, by high scores on several lists, and by chemical.

SICs with High Employment in LA County

To relate the industry rankings to a particular geographical location, one must compare the results of hazard ranking with actual employment patterns in the target location. If high employment (SICs with greater than 5,000 employees) in Los Angeles County is matched with SICs showing high exposures in the IBER inspection rankings, eight SICs are both above 5,000 employment and rank in the top 20 per cent on three or more IBERs (Table 3). Three of these eight SICs—7699, repair services (NEC); 3444, sheet metal work; and 3411, metal cans—also rank high on either OWI or IRI. The list is short because the majority of SICs which have very high employment are service industries which either were seldom inspected or were shown to have relatively low exposures upon inspection. One service industry (drycleaning, 7216) was found to have high exposures (perchloroethylene).

When setting priorities for intervention, however, one also needs to consider the average workplace size within an industry. Drycleaning has a large number of workers but a small workforce in each plant, and thus would require substantial resources if it were a major target for hazard surveillance. The development of methodologies for surveillance in small industries represents a continuing and significant challenge to health professionals.

In comparing high employment and high *potentially* hazardous exposure rankings (OWI or IRI), we found 16 SICs

TABLE 1—Top 25 SICs Ranked by the Inspection Based Exposure Rating (IBER)

IBER Rank	SIC[a]		Mean Severity[b]	Median Severity[b]	No. of Substances w/Exposure 50[c]/ Total No. Substances	IRI/OWI Rank	Los Angeles County Employment
1	3341	Secondary Non-ferrous Metals	3.01	0.21	15/34	+/383	1,009
2	3691	Storage Batteries	2.93	0.70	4/12	319/33*	702
3	3731	Ship Building	2.25	0.17	15/25	69*/4*	4,905
4	3743	Railroad Equipment	2.54	0.13	16/35	+/31*	170
5	3321	Gray Iron Foundries	0.70	0.25	13/38	270/32*	1,982
6	3362	Brass, Bronze, Copper	1.10	0.46	8/25	335/231	1,459
7	1622	Bridge, Tunnel, Elevated Construction	15.51	0.56	5/9	+/157	147
8	3523	Farm Machinery	1.63	0.20	8/20	+/232	402
9	2816	Inorganic Pigments	2.44	0.83	6/13	29*/322	194
10	1389	Oil and Gas Field Service	28.27	1.31	2/4	226/337	2,695
11	5093	Scrap and Waste Materials	1.53	0.80	5/14	+/395	3,845
12	3253	Ceramic Wall and Floor	12.09	1.70	3/5	+/+	393
13	2819	Industrial Inorganic Chemicals	1.49	0.17	14/31	107/110*	2,316
14	3332	Primary Lead	3.33	1.44	5/6	+/+	0
15	3331	Primary Copper	1.18	0.40	8/15	+/644	0
16	3715	Truck Trailers	1.65	0.13	8/16	49*/29*	1,002
17	3531	Construction Machinery	0.96	0.07	11/27	379/12*	1,601
18	3433	Heating Equipment	6.45	0.09	6/22	140/304	658
19	2821	Plastics and Resins	1.26	0.05	17/46	12/44*	3,131
20	3325	Steel Foundries, NEC	0.47	0.19	8/26	+/3*	1,845
21	3229	Pressed and Blown Glass	1.12	0.14	8/20	+/+	1,629
22	3312	Blast Furnaces, Steel Mills	0.48	0.09	15/32	182/160	3,043
23	3713	Truck and Bus Bodies	1.60	0.11	7/17	219/111*	2,247
24	3714	Motor Vehicle Parts	0.74	0.05	16/40	306/154	10,714
25	1761	Roofing and Sheet Metal	1.81	0.56	2/7	272/79*	4,673

NOTE: Acronyms are defined on first page of text.
*Top 20% of either IRI or OWI.
[a]Standard Industrial Classification Manual, 1972.
[b]Severity is exposure level measured as a proportion of the Permissible Exposure Limit (PEL).
[c]Number of substances with at least one test sample over 50% of the PEL.
+No ranking; Did not meet minimum NOHS criteria.

TABLE 2—Top 15 SICs in the IRI, OWI Ranking System and by Employment in Los Angeles County

SIC[a]	IRI	Rank	SIC[b]	OWI	Rank	SIC	Place of Employment	Los Angeles County Employment
3496	Miscellaneous Fabricated Wire Products	1	3996	Hard Surface Floor Covering	1	8062	Hospitals	129,446
2834	Pharmaceutical Preparations	2	3269	Pottery Products, NEC	2	5812	Eating Places	101,847
2893	Printing Ink	3	3325	Steel Foundries, NEC	3	3662	Radio and TV Communications	84,844
2851	Paints, Allied Products	4	3731	Ship Building and Repair	4	1311	Crude Petroleum, Gas	76,185
2295	Coated Fabrics, Not Rubber	5	3479	Metal Coating, Allied Products	5	8211	Elementary, Secondary Schools	65,660
3565	Industrial Patterns	6	3565	Industrial Patterns	6	7399	Business Services, NEC	44,928
2843	Surface Active Agents	7	2791	Typesetting	7	5311	Department Stores	40,163
2992	Lubricating Oils, Grease	8	2843	Surface Active Agents	8	8111	Legal Services	33,696
2833	Medicinals and Botanicals	9	2661	Building Paperboard Mills	9	7392	Management, Public Administration	32,625
2842	Polishes, Sanitation Goods	10	3446	Architectural Metal Work	10	6331	Fire, Casualty Insurance	32,432
1381	Drilling Oil and Gas	11	3531	Construction Machinery	11	8911	Engineering, Architectural Services	30,350
2821	Plastics Materials, Resin	12	3443	Fabricated Plate Work	12	5411	Grocery Stores	30,172
2262	Finishing Synthetic Textile	13	3568	Power Transmission Equipment	13	6411	Insurance Agents	29,692
3996	Hard Surface Floor Cover	14	2842	Polishes, Sanitation Goods	14	6531	Real Estate Agents	29,307
8931	Accounting, Auditing	15	2822	Synthetic Rubber	15	3599	Machinery, Except Electric, NEC	28,670

NOTE: Acronyms are defined on first page of text.
[a]Standard Industrial Classification Manual, 1967.
[b]Standard Industrial Classification Manual, 1972.

with: 5,000 or more employees in Los Angeles County; a ranking in the top 20 per cent on one list; as well as a ranking in the top 40 per cent of the other list (OWI or IRI). Ten of the 16 SICs are listed in Table 4. Because the NOHS survey, on which both the OWI and IRI are based, includes a broad spectrum of industries, service industries, as well as wholesale and retail trades, appear on this list. There are six SICs in the top 20 per cent on both potential exposure measures and two of these also have IBER ratings in the top 20 per cent for two out of the four IBER ratings: Car Dealers (New and Used), and Toilet Preparations. Car Dealers include auto maintenance and repairs as well as detailing of new cars. Toilet Preparations involves exposures to many chemicals and recorded overexposures to talc and silica.

Two medical service SICs appear on this list due to high IRIs. The NOHS survey of these SICs recorded the presence of biologicals and pharmaceuticals, many of which are highly toxic but are not regulated by OSHA and not included in the OWI. Table 4 broadens the types of SICs which may be targeted by selecting industries high in employment which have not been extensively inspected or where important exposures may exist to substances which are infrequently tested in inspections.

In assessing employment patterns, it is important not to set arbitrary numerical cutoffs. There are 308 Los Angeles County SICs in which more than 2,000 persons are employed, accounting for more than 90 per cent of the working population in the County. If a 2,000-person cutoff were used to identify the most important industries, the following highly hazardous industries would be dropped from consideration: grey iron foundries, storage batteries, secondary lead smelting, and brass-bronze foundries. These industries together employ only 5,000 persons (total) in the County, but they have histories of high exposure.

SICs Rated High on Overlapping Systems

Since the three ranking systems derive from two different data bases and are based on differing assumptions, it is not surprising that industries ranking high in one system may not rank high in another. Nevertheless, if an industry appears on the top of several lists, it indicates that there is a history of documented overexposures to certain chemicals and of potential exposures to a number of other highly toxic substances, and that a significant number of workers are thought to be exposed. For purposes of comparison, SICs appearing

TABLE 3—SICs with High Los Angeles County Employment[a] and with High Inspection-Based Exposure Ratings[b]

			IBER			
SIC	Name	Los Angeles County Employment	# Ratings Ranked in Top 20%	No. of Substances Inspections	OSHA Weighted Index Rank	IRI Rank
3079	Miscellaneous Plastics Products, NEC	24,926	3	532	286	87
3714	Motor Vehicle Parts	10,714	4	274	154	306
7699	Repair Services, NEC	9,417	4	42	27	60
3533	Oil Field Machinery	7,097	3	233	199	100
3444	Sheet Metal Work	7,093	3	98	42	290
1611	Highway, Street Construction	6,437	3	6	399	356
3411	Metal Cans	5,955	3	79	43	41
7216	Dry Cleaning	5,201	3	32	562	124

NOTE: Acronyms are defined on first page of text.
[a]Employment > 5,000.
[b]Number of IBERs in top 20% ≥ 3.

TABLE 4—SICs with High Los Angeles County Employment (> 5,000) and Moderate to High[a] Ranks on the OWI and the IRI

SIC	Name	Los Angeles County Employment	OWI Rank[b]	IRI Rank	IBER Rank	IBER No. Ratings Ranked in Top 20%
8062	Hospitals	129,446	248	26+	180	0
7349	Bldg. Maintenance	23,987	169	29+	287	0
5511	Car Dealers	23,764	39+	36+	250	2
3679	Electronic Components	23,551	120+	132	277	0
3369	NonFerrous Foundry	16,667	105+	156	78	2
8011	Offices of Physicians	16,234	188	65+	—	—[c]
1711	Plumbing, Heating	15,961	46+	232	133	2
2844	Toilet Preparations	14,198	112+	19+	143	2
2752	Commercial Printing	13,573	54+	33+	206	0
5084	Industrial Machinery	12,450	175	68+	—	—

NOTE: Acronyms are defined on first page of text.
[a]At least one rank is in top 20% and other in top 40% of all SICs.
[b]Rank is for the 3-digit SIC in nonmanufacturing SICs (all SICs except those where the first digit is 2 or 3).
[c]Fewer than 3 inspections in the SIC.
+The SIC ranks in the top 20% of all SICs in that rating system.

on the top 20 per cent of each ranked list were considered to have "high scores" and were examined for overlap.

With no consideration of Los Angeles County employment, there were 71 SICs that appeared in the top 20 per cent of at least three out of the four IBER listings. Of these 71, 26 SICs also appeared in the top 20 per cent on the OWI listing of SICs, and 10 were in the top 20 per cent on the IRI list. Eight SICs were in the top 20 per cent of SICs in all three ranking methods (Table 5). Twenty additional SICs were in the top 20 per cent of rankings on at least three IBERs and either the OWI (19) or IRI (1). The bottom half of Table 5 (starting with SIC 1761) lists the first 10 of these 20 SICs.

The eight SICs with overlap between IBERs, OWI, and IRI are manufacturing industries, with the exception of SIC 7699, repair services. Table 6 lists those chemicals from OSHA's "highly hazardous" group (ranked 7 or 10) found in the eight SICs for which inspection results showed at least one test sample exceeding 50 per cent of the permissible exposure limit (PEL). The number of chemicals sampled and the number of regulated substances found in that SIC (as listed in the OWI) are also given.

Profiling Specific Chemicals

The focus thus far has been the development of priorities by grouping chemicals being used in a particular SIC code. Another approach is to utilize MIS data to focus on the compliance history of a specific chemical. In the case of silica, this approach has the advantage of being able to

TABLE 5—SICs Ranking in the Top 20% of IBERs[a] and in at least One of the other Two Systems (OWI and IRI)

SIC	Label	IBER Rank	OWI Rank	IRI Rank	Los Angeles County Employment	Average Size of Plant*
2821	Plastics, Resins	19	44 +	12+	3131	46
2851	Paints, Allied Products	37	41 +	4+	3205	28
3269	Miscellaneous Pottery Products, NEC	27	30 +	39+	3121	31
3411	Metal Cans	72	43 +	41+	5955	238
3479	Metal Coating	71	5 +	76+	3006	19
3715	Truck Trailers	16	29 +	49+	1002	72
3731	Shipbuilding	3	4 +	69+	4905	288
7699	Repair Services, NEC	51	27[c]+	60+	9417	6
1761	Roofing, Sheet Metal	25	79[c]+	272	4673	10
2819	Industrial Inorganic Chemicals	13	110 +	107	2316	28
2899	Chemical Preparations, NEC	69	195	60+	2453	22
3221	Glass Containers	70	96 +	210	3656	243
3361	Aluminum Foundries	28	78 +	260	4451	41
3443	Fabricated Plate	31	13 +	296	3691	38
3444	Sheet Metal Work	85	42 +	290	7093	20
3499	Fabrics, Metal, NEC	56	88 +	188	3022	21
3589	Service Industrial Machinery	46	114 +	228	2002	26
3713	Truck, Bus Bodies	23	111 +	219	2247	42

NOTE: Acronyms are defined on first page of text.
[a]Inspection Based Exposure Rankings from OSHA inspections 1980–82; 4 rankings were calculated.
[b]SICs ranking in the top 20% in all three systems are listed first. Each group is in SIC order.
[c]These OWIs are based on 3-digit SIC calculations for SICs 176 and 769.
+Rank is in top 20% of all SICs in this ranking system.
*Number of employees.

TABLE 6—Substances Contributing to High IBER Ranks for Selected SICs

SIC	Industry	No. of Substances in OWI[a]	No. of Substances Sampled by OSHA[b]	Substances with Levels over 50% of PEL Found in OSHA Inspections[c]
2821	Plastics Manufacturing	256	46	1. Lead 2. Vinyl Chloride 3. Acrylonitrile 4. Carbon Disulfide 5. TDI[d] 6. Silica 7. Antimony 8. Coal Tar Pitch Volatiles 9. Nitrogen Dioxide 10. Cadmium 11. Trichloroethane 12. Propylalcohol 13. Mercury 14. Toluene 15. Asbestos
2851	Paint Manufacturing	347	35	1. Lead 2. Silica 3. Toluene 4. Chromium 5. Trichloroethylene 6. Xylene 7. Carbon Tetrachloride 8. Asbestos 9. Mercury
3269	Pottery, Miscellaneous	177	7	1. Silica 2. Lead 3. Arsenic
3411	Metal Cans Manufacturing	250	21	1. Lead 2. Chromium 3. Asbestos 4. Cutting Oils 5. Beryllium 6. Ethylene Dichloride
3479	Metal Coatings	165	29	1. Coal Tar Pitch Volatiles 2. Chromium 3. TDI/MDI[d] 4. Toluene 5. Xylene 6. Zinc Chloride 7. Carbon Black 8. Sulfuric Acid
3731	Shipbuilding	238	25	1. Lead 2. Iron Oxide 3. Silica 4. Asbestos 5. Coal Tar Pitch Volatiles 6. Beryllium 7. Cobalt 8. Zinc Chromate 9. Arsenic 10. Antimony Oxide 11. Vanadium Oxide 12. Manganese Oxide
7699	Repair Services	221	18	1. Lead 2. Iron Oxide 3. Toluene 4. Xylene 5. Asbestos 6. Cobalt 7. Zinc Chromate

[a]OSHA Weighted Index.
[b]From OSHA inspections 1979–1982.
[c]Listed by proportion of exposures over 50% of PEL in descending order.
[d]Toluene diisocyanate, Methylene diisocyanate.

identify overexposures by SIC and by job title within a SIC and to identify SICs in which there has not been general recognition that excessive silica exposure might be occurring.[13]

Some of the industries with demonstrated overexposures to silica rank low on IBERs because there was a limited number of substances besides silica with significant exposure levels (e.g., internal combustion engines, pumps and pumping equipment). These industries would be identified only if attention were given specifically to silica.

Another example is asbestos: of the eight industries that were in the top 20 per cent of all three ranking systems, five had at least one asbestos sample greater than 50 per cent of the PEL (two fibers per cubic centimeter). Moreover, it is generally agreed that the current PEL is inadequate—the PEL recommended by NIOSH is 0.1 fibers/cc.

Discussion

Occupational health surveillance strategies to prevent workplace illness and disease derived from chemical exposures can serve as a baseline for routine (annual or multiyear) surveillance of hazard levels and distributions. The methods we have described can be used elsewhere in designing hazard profiles addressed to local employment patterns.

These methods are only a first step in development of possible approaches to using OSHA MIS data. Limitations in the current data base itself are correctable weaknesses, and should not obscure the value of having actual exposure information from which to define hazard surveillance programs. The OSHA MIS data base will have wider utility, with greater confidence in its usefulness, as its weaknesses are addressed.

Prior to this study, there were two earlier efforts to prioritize hazardous industry.[10,12] In addition, a 1978 NIOSH report sought to provide health planners with means to identify health care needs for occupational disease.[14] That effort did not rely on the assessment of chemical use or exposure level but used a consensus panel to rank industry. Prioritization of industry was based on employment size or relied on the identification of 20 two-digit SICs judged hazardous by the consensus panel; the use of two-digit SIC codes made each industry category quite broad in scope.

We believe our approach provides a sharper focus on industries in Los Angeles County than was possible using the 1978 NIOSH report. As one of several examples, SIC 3411 (metal can manufacture) was not identified in the NIOSH report but is included in our study as an industry deserving follow-up in Los Angeles County because of significant employment and high rankings in IBER, OWI, and IRI. Federal OSHA inspections found the following chemicals present in SIC 3411 at mean severity levels greater than 50 per cent of the PEL: lead, chromium, asbestos, cutting oils, beryllium, and ethylene dichloride.

Identifying overlap between ranking systems is useful in choosing industries for initial follow-up. The overlap between IRI/OWI and IBER enabled us to identify 28 SICs on the top 20 per cent of both the IRI/OWI and IBER lists. Closer analyses of the overlap between OWI and individual IBER ranking lists yield additional SICs for study.

Although there are significant areas of overlap among the three ranking systems, there are also major areas where overlap did not occur (see Tables 1 and 2). The lack of consistent overlap between the IBER and IRI ranking systems underscores the differences in the data bases on which they rely and the underlying assumptions in each method. The NOHS was based on a probability sampling scheme designed to build a nationally representative data base. Because exposure levels were not measured, it is difficult to evaluate which of the chemicals found in a given SIC actually present hazards.

The OSHA MIS contains data derived from compliance inspections. OSHA compliance officers inspect industries where they anticipate specific overexposures to agents for which there are existing standards. Therefore, IBER rankings reflect measured exposures of individual workers, but this sole source of exposure data—inspection records—is limited in scope and may not be representative of an entire industry. Nevertheless, the data do identify real problems of chemical overexposure for the sample of industries studied and thus represent a significant point of departure for surveillance.

Another difference in the data bases is their choices for which chemicals to target. IRI rankings are based on all chemicals in a SIC which have RTECS data, whereas OSHA often targets specific industries and chemicals within a SIC category. For example, within 2821 (plastics), OSHA is likely to have given more attention to vinyl chloride and acrylonitrile polymerization plants (due to the carcinogenicity of the monomers) than to some other plastics manufacturing plants in which NIOSH might have found present a wide variety of solvents and other chemicals.

The relative utility of the data bases and approaches described here also depend on the end use of the data. Health professionals may want to use hazard surveillance information for any of the following reasons: intervention, tracking control of exposures over time, planning, research, as a complement to disease surveillance, and standard setting.

Where intervention is necessary because of high exposures to documented hazards, the OSHA MIS information and the IBER rankings are especially advantageous. The nature of the intervention may be compliance activity by a regulatory agency, specifically tailored health education programs, control technology studies, the requirement for establishment of respirator and environmental and biological monitoring programs, or disease surveillance.

Although the extensive records developed by OSHA are somewhat circumscribed by the fact that the agency focuses on a limited number of substances and industries, the OSHA MIS and state plan MIS data represent the only currently available sources of industrial hygiene information collected over time.

For planning purposes, the first step is to define the industries in a geographical area. The ranking methods identified here can then be applied. Whether the NOHS or MIS based systems are used depends upon the nature of the planning to be conducted. Planning whose goal is the assessment of clinical services available to meet a toxic emergency, such as a chemical spill or uncontrolled release, will undoubtedly make use of both data bases, whereas actual exposure information will be useful in the setting of inspection or other intervention priorities.

Both data base systems and the associated rankings are relevant to research. Where the objective is to study the adequacy of a particular standard, the MIS data identify exposure levels below the current standard and provide exposures by job title. The MIS data may also be used to develop cause-effect relationships where the outcome is related to a compound for which there exists an OSHA standard but for which there is a previously unrecognized disease outcome.

In general, epidemiologic research which seeks to establish a new cause-effect relationship between a particular health outcome and work-related exposure will be better informed by having the NOHS data available. One way to target use of the NOHS data for epidemiologic research might be to focus on industries ranked high in the IRI with significant employment patterns in a defined area.

Where disease surveillance efforts have identified populations at risk, both the NOHS and OSHA MIS data bases have utility. The IRI/OWI provides information on the scope

of the chemicals in use and IBER gives information on exposure levels to certain of the substances in use. Use of the data to complement disease surveillance efforts represents an especially important use of hazard surveillance information. For example, data from airborne lead exposure monitoring and biological monitoring of blood lead levels are mutually reinforcing.[15] Information from cancer registries indicating industries at high risk of cancer represent an example where both data systems will also have utility. The OSHA MIS and NIOSH NOHS may be reviewed to identify specific substances for follow-up which may have etiologic significance in those industries in which there are suspected excesses of work-related cancer. The availability of occupational data in these systems may enable an even closer evaluation of risk factors.

Mendeloff has argued that the OSHA MIS data can be used to develop standards.[16] Although not derived from a random sample, for certain industries or chemicals the data are exceedingly large and represent reasonable estimates of the numbers and distribution of workers exposed. The NOHS data also provide an estimate of the number of workers exposed to particular chemicals and the two data systems can be coupled to estimate the distribution of workplace exposures.

Sole use of inspection data for hazard surveillance would result in a continual narrowing of the industries inspected, however. It is essential, therefore, to broaden the range of chemicals and industries under investigation. An important source of information for hazard surveillance should be industry-generated environmental monitoring data. Unfortunately, OSHA requires monitoring for only a very few substances, and, in contrast to similar monitoring requirements under the Mine Safety and Health Administration for coal dust, the data collected by industry are not reported to OSHA or NIOSH. The promulgation of a generic OSHA standard which requires environmental monitoring for a larger number of agents with subsequent reporting to OSHA for inclusion in the MIS would represent an important contribution to hazard surveillance.

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