The Prevalence of Screening in Industry: Report from the National Institute for Occupational Safety and Health National Occupational Hazard Survey

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Data from 4,500 workplaces surveyed by the National Institute for Occupational Safety and Health (NIOSH) in the National Occupational Hazard Survey (1972 to 1974) and National Occupational Exposure Survey (1981 to 1983) show an increase in both preplacement and periodic medical screening in US industries during the past decade. The distribution of screening is primarily related to plant size, but also varies considerably by industry type; further, plants with industrial hygiene and safety programs and/or unions are more likely to provide screening examinations than those without, irrespective of plant size. As for workers potentially exposed to selected chemical hazards, the first survey provides no consistent evidence that such workers were more likely to receive exposure-specific tests than other workers. The significance of these findings is discussed in the context of the proposed framework for medical screening practices developed by NIOSH researchers.

The medical screening of workers through occupational health programs is a common practice in private industries in the United States, and is recommended for all workers by such groups as the American Medical Association and the American Occupational Medical Association.[1,2] The National Institute for Occupational Safety and Health (NIOSH) and the Occupational Safety and Health Administration (OSHA) jointly recommend screening tests for workers exposed to any of 386 chemicals listed under the Standards Completion Project, including approximately 120 for which NIOSH criteria documents have been issued.[3] In addition, federal regulations promulgated by OSHA require medical screening tests for workers exposed to a total of 25 chemical agents. The majority of medical screening programs, however, have been initiated by the employer.

The purpose of this paper is, first, to describe the distribution of medical screening practices in US private industry according to factors that affect this distribution such as plant size and industry type, and to make some preliminary observations on changes in these practices over the past decade. Second, this paper will briefly examine the relationship of screening practices to the provision of health and safety measures such as industrial hygiene monitoring and the use of personal protective equipment. Finally, and most important from the viewpoint of the prevention of work-related disease, this paper will explore the relationship between potential exposure to selected chemical and physical agents and the provision of relevant specific screening tests. The analysis presented below will be discussed in the context of medical screening as presented elsewhere at this conference.[4]

Data Base

The analysis that follows uses data from the NIOSH National Occupational Hazard Survey (NOHS) (1972

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to 1974) and preliminary data from the second NIOSH National Occupational Exposure Survey (NOES) (1981 to 1983) (Ref 5 and unpublished data from the NIOSH NOHS 1972 to 1974 and NOES 1981 to 1983). In both surveys, a stratified, multistaged probability sampling technique was used to select approximately 4,500 workplaces in the US. These strata represent the range of plant sizes and industry types classified according to the 1967 and 1972 Standard Industrial Classification (SIC) codes, but exclude mining, agriculture, and federal and state industries or businesses not covered by the Occupational Safety and Health Act. From these sampling designs, national estimates for numbers of plants and employees represented by the sample were generated for both surveys. The estimated percentage distributions of plants and employees represented by the sample are given in Table 1 (Ref 5 and unpublished data from the NIOSH NOHS 1972 to 1974 and 1981 to 1983). Data on the number of employees in each job category, medical screening practices, industrial hygiene and safety practices, and other demographic information were collected by personal interview and recorded on a questionnaire. Walk-through surveys of the plant were conducted by trained surveyors to catalog chemical, physical, and biological agents to which workers were potentially exposed (ie, agents that were observed in use in accordance with a set of training instructions). The analysis that follows will focus on the distribution of preplacement examinations given before a worker is employed or assigned to a particular job, and on periodic examinations given at intervals during the course of employment. In all the tables that follow, responses are included only where either all employees or production workers were given these examinations; responses are not included where only management or executive personnel were offered the examinations.

Current Medical Screening Practices

The estimated percentage of workers provided with preplacement and periodic examinations in 1972 to 1974 and 1981 to 1983 is given in Table 2. These data show that more workers have preplacement than periodic examinations both then and now; further, the proportion of workers given these examinations has increased over the decade by approximately 23% and 19%, respectively. The distribution of these examinations according to plant size is given in Table 3. From 1972 to 1974, workers in large plants (those with more than 500 workers) were approximately four times more likely to be given these examinations than workers in small plants (those with fewer than 100 employees) and twice as likely as those in medium-sized plants. This difference in distribution by plant size appears not to have changed substantially during the course of the decade.

With respect to specific components of periodic screening tests, companies were asked in both surveys whether all, or selected groups of employees, were given the following tests: ophthalmologic and audiometric examinations, chest radiographs, pulmonary function tests, blood and urine tests, and immunizations, and in the second survey only, allergy tests (Table 4). At the time of the first survey, chest radiographs were the most commonly provided of these examinations given to a total of 25% of the work force, followed by ophthalmologic (22%) and audiometric tests (21%). Slightly less than 15% of the work force were given blood, urine, or pulmonary function tests. Ten years later, the percentage of workers given these tests had increased in each case, but not equally. The percentage of workers with blood, urine, audiometric, and pulmonary function tests had approximately doubled. The use of ophthalmologic testing and chest radiographs increased more modestly, by 40% and 32%, respectively.

As expected from the data presented in Table 3, workers in larger plants are more likely to be given these specific tests than those in smaller plants, both in

TABLE 2
Estimated Percentage of Workers With Screening Examinations

Type of Examination	Estimated % of Workers	
	1972–1974	1981–1984
Preplacement	47.7	58.8
Periodic	33.7	40.2

Source: National Institute for Occupational Safety and Health (NIOSH) National Occupational Hazard Survey 1972–1974; NIOSH National Occupational Exposure Survey 1981–1983 (preliminary data).

TABLE 1
Estimated Percentage Distribution of Plants and Employees Represented in the National Institute for Occupational Safety and Health (NIOSH) National Occupational Hazard Survey (NOHS) (1972–1974) and National Occupational Exposure Survey (NOES) (1981–1983)

		Estimated % of Workers		
		Small Plants (<100 Workers)	Medium Plants (100–499 Workers)	Large Plants (>500 Workers)
Plants	1972–1974	91.0	8.1	1.2
	1981–1983	77.8	9.8	1.8
Employees	1972–1974	40.0	28.0	31.0
	1981–1983	33.4	29.7	37.0

Total no. of plants surveyed: 4,636 (1972–1974); 4,490 (1981–1983).
Estimated total no. of plants represented: 739,244 (1972–1974); 507,997 (1981–1983).
Total no. of employees in surveyed plants: 895,668 (1972–1974); 1,820,634 (1981–1983).
Estimated total no. of employees represented: 38,262,627 (1972–1974); 33,120,289 (1981–1983).

Source: NIOSH National Occupational Hazard Survey 1972–1974; NIOSH National Occupational Exposure Survey 1981–1983 (preliminary data).

TABLE 3
Estimated Percentage of Workers With Screening Examinations by Size of Plant

Type of Examination	Estimated % of Workers					
	Small Plants (<100 Workers)		Medium Plants (100–499 Workers)		Large Plants (>500 Workers)	
	1972–1974	1981–1983	1972–1974	1981–1983	1972–1974	1981–1983
Preplacement	19.2	26.6	48.9	56.4	83.3	87.8
Periodic	12.2	13.4	29.3	38.1	65.4	68.8

Source: National Institute for Occupational Safety and Health (NIOSH) National Occupational Hazard Survey 1972–1974; NIOSH National Occupational Exposure Survey 1981–1983 (preliminary data).

TABLE 4
Estimated Percentage of Workers With Specific Periodic Examinations

Test	Estimated % of Workers	
	1972–1974	1981–1983
Chest radiograph	25.0	33.0
Ophthalmologic	22.3	31.4
Audiometric	21.4	40.2
Blood	14.7	36.0
Urine	14.4	34.9
Pulmonary function	13.5	28.9
Allergies	*	7.4
Immunizations	24.2	19.0

* Information not recorded.
Source: National Institute for Occupational Safety and Health (NIOSH) National Occupational Hazard Survey 1972–1974; NIOSH National Occupational Exposure Survey 1981–1983 (preliminary data).

1972 and 1981 (Table 5). Furthermore, it appears that use of such tests in small and medium-sized plants has undergone a greater proportional increase than in large plants over the decade.

The percentage of workers with screening examinations also varies markedly with industry type. Differences among industries appear to be as great in the 1980s as in the 1970s (Table 6), although the prevalence of screening has increased in most but not all sectors. For example, workers in transportation and public utility industries were the most likely group to have preemployment examinations in both the 1972-to-1974 period and the 1981-to-1983 period (an estimated 82% and 73%, respectively), in comparison with only 8% and 12%, respectively, of construction workers. Similar differences between industries can be observed for specific periodic examinations, of which two examples are shown in Table 6. The question of whether these differences appear to reflect differences in occupational hazards will be addressed below.

Relationship Between Screening and Health and Safety Facilities

The data available from the NOHS and NOES suggest that an increase in the provision of certain preventive health and safety measures has taken place during the last decade (Table 7). Currently, approximately half the work force surveyed are employed in plants where environmental monitoring is conducted or where personal protective equipment is required, compared with a third or less of the work force in 1972. Nevertheless, the majority of workers are currently employed in plants without on-site industrial hygienists and safety engineers. Again, the extent to which these services are provided varies markedly depending on the size of the plant (Table 7).

Using data available from the NOHS and after stratification by plant size, logistic regression analysis was used to quantitatively examine the relationship between the provision of medical screening and the use of industrial hygiene or environmental protection practices, denoted by the use of environmental monitoring, personal protective equipment, the employment of an industrial hygienist, or all of these measures. The effect of the presence of unions in the plants was also examined in this model, based on a descriptive analysis indicating that screening was more prevalent in unionized plants of different sizes than in nonunionized plants. Taking into account the effect of plant size, the prevalence of preplacement examinations was significantly higher ($P = .001$) in plants where monitoring and personal protection were used and where industrial hygienists were employed. The prevalence of periodic examinations was not significantly related to the provision of these measures, but was significantly higher ($P = .001$) in unionized plants than in nonunionized plants.

Relationship Between Screening and Workplace Hazards

Thus far, some of the major factors that affect the overall distribution of screening in industry have been identified, and a link between screening and other preventive measures has been suggested. In regard to early intervention and prevention of work-related disease, the question that needs addressing is whether screening examinations are related to the presence of hazards in the workplace. Data from the first NOHS have been used to examine this relationship although exposure data from the second survey are not yet edited and available for analysis. Because some 8,000 different agents were observed in the NOHS, it is impossible here to explore this relationship for potential exposures to all single or multiple agents. For that reason, this analysis is confined to the distribution of general and specific periodic examinations among workers potentially exposed to selected chemicals of established toxicity and, in the majority of cases, chemicals for which specific medical screening recommendations had been made by NIOSH or promulgated by OSHA by 1974.

TABLE 5
Estimated Percentage of Workers With Specific Periodic Examinations by Size of Plant

Type of Examination	Estimated % of Workers					
	Small Plants (<100 Workers)		Medium Plants (100–499 Workers)		Large Plants (>500 Workers)	
	1972–1974	1981–1983	1972–1974	1981–1983	1972–1974	1981–1983
Chest radiograph	8.6	8.0	20.4	21.2	50.1	65.2
Ophthalmologic	6.7	11.1	15.8	22.5	48.2	56.9
Audiometric	5.2	13.4	13.8	38.1	48.1	66.3
Blood	3.6	10.7	7.9	23.7	35.2	68.8
Urine	3.1	10.7	8.4	23.3	34.3	66.0
Pulmonary function	3.4	8.7	8.4	19.0	31.1	55.1
Allergies	*	1.8	*	4.2	*	15.1
Immunizations	7.8	3.3	22.0	11.7	47.1	32.3

* Information not recorded.
Source: National Institute for Occupational Safety and Health (NIOSH) National Occupational Hazard Survey 1972–1974; NIOSH National Occupational Exposure Survey 1981–1983 (preliminary data).

TABLE 6
Estimated Percentage of Workers With Screening Examinations by Industry Type

Industry Sector	Estimated % of Workers					
	Preplacement		Blood (Periodic)		Chest Radiograph (Periodic)	
	1972–1974	1981–1983	1972–1974	1981–1983	1972–1974	1981–1983
Transportation/public utilities	81.6	72.7	12.2	32.6	32.7	28.5
Manufacturing	67.0	61.8	24.1	35.0	35.9	33.6
Services	40.9	69.0	13.7	59.5	30.5	53.7
Wholesale/retail trade	22.0	34.6	5.9	17.3	13.9	13.0
Finance/insurance	33.2	*	1.0	*	7.3	*
Contract construction	8.0	12.0	11.0	9.3	4.0	8.3

* Not surveyed in NOES.
Source: National Institute for Occupational Safety and Health (NIOSH) National Occupational Hazard Survey 1972–1974; NIOSH National Occupational Exposure Survey 1981–1983 (preliminary data).

TABLE 7
Estimated Percentage of Workers With Health and Safety Facilities

Type of Examination	Estimated % of Workers					
	Small Plants (<100 Workers)		Medium Plants (100–499 Workers)		Large Plants (>500 Workers)	
	1972–1974	1981–1983	1972–1974	1981–1983	1972–1974	1981–1983
Industrial hygienist and safety engineer on site	*	0.5	0.1	3.9	14.0	40.0
Regular environmental monitoring	2.5	11.1	12.0	43.4	55.0	85.1
Personal protective equipment required	31.4	45.9	46.0	59.0	42.0	56.0

* Insufficient number to provide estimate.
Source: National Institute for Occupational Safety and Health (NIOSH) National Occupational Hazard Survey 1972–1974; NIOSH National Occupational Exposure Survey 1981–1983 (preliminary data).

First, the percentage of workers potentially exposed to a given agent who are provided with a specific test is compared with the percentage for all workers. In Table 8, the percentage of workers potentially exposed to selected chemicals who were offered both preplacement and periodic screening is compared with the percentage for all workers. These data suggest that these workers were not consistently more or less likely to be given such examinations than the average. Further, as may be expected, a much smaller percentage of potentially exposed workers in smaller plants is screened than in large plants (Table 9).

With respect to specific tests, some representative examples of which are shown here, a similar pattern is observed: the proportion of workers who are potentially exposed to one or more of the dusts shown in Table 10 and who have periodic chest radiographs or pulmonary function tests is only slightly higher than the proportion for all workers, as is the percentage of workers potentially exposed to heavy metals who receive periodic blood

or urine tests (Table 11). The percentage of workers potentially exposed to continuous noise who have audiometric tests is considerably higher than that for workers exposed to impact noise and all workers (Table 12).

The distribution of these tests for potentially exposed workers and all workers was also compared within and among industries (Tables 13 and 14). Such findings suggest that, at least for the agents examined, exposed workers were not consistently more or less likely to receive recommended tests than all workers in plants of the same industry type, with certain exceptions such as workers exposed to heavy metals and dusts in transportation industries. Second, industries differ markedly with respect to the percentage of potentially exposed workers who are screened, which tends to reflect the overall prevalence in that industry. Thus, those workers in the construction industry, for example, are considerably less likely to have certain periodic tests than those in transportation, irrespective of their potential exposure to specific hazardous agents.

TABLE 8
Estimated Percentage of Workers Potentially Exposed to Selected Chemicals With Preplacement and Periodic Screening Examinations

Agent	Estimated % of Workers
Carcinogens regulated by OSHA*	20.0
Cadmium	24.2
Lead	24.9
Lead oxides	35.5
Asbestos	20.5
Vinyl chloride	30.1
Toluene diisocyanate	52.1
All workers	**29.0**

* Carcinogens regulated by the Occupational Safety and Health Administration (OSHA) (1974)[8] observed in the NOHS: 4-aminodiphenyl, 3,3-dichlorobenzidine, 4-dimethylaminoazobenzene, α- and β-naphthylamine, N-nitrosodimethylamine, β-propriolactone, ethyleneimine, and benzidine.
Source: National Institute for Occupational Safety and Health (NIOSH) National Occupational Hazard Survey 1972–1974.

TABLE 9
Estimated Percentage of Workers Exposed to Selected Chemicals With Preplacement and Periodic Examinations, by Plant Size

Agent	Estimated % of Workers	
	Small/Medium Plants (<500 Workers)	Large Plants (500 or more Workers)
Carcinogens regulated by OSHA*	6.6	50.7
Cadmium	6.5	81.8
Lead	12.1	73.8
Lead oxides	19.9	67.1
Asbestos	9.1	75.2
Vinyl chloride	8.7	69.2
Toluene diisocyanate	5.6	97.4
All workers	**17.0**	**64.0**

* Carcinogens regulated by the Occupational Safety and Health Administration (OSHA) (1974)[8] observed in the NOHS: 4-aminodiphenyl, 3,3-dichlorobenzidine, 4-dimethylaminoazobenzene, α- and β-naphthylamine, *N*-nitrosodimethylamine, β-propriolactone, ethyleneimine, and benzidine..
Source: National Institute for Occupational Safety and Health (NIOSH) National Occupational Hazard Survey 1972–1974.

TABLE 10
Estimated Percentage of Workers Potentially Exposed to Dusts* With Periodic Chest Radiographs or Pulmonary Function Tests (PFT)

	Estimated % of Workers	
	Chest Radiograph	PFT
Exposed	27.8	17.0
All Workers	24.6	14.0

* One or more dusts of cotton, silica, mica, talc, fiberglass, or coal.
Source: National Institute for Occupational Safety and Health (NIOSH) National Occupational Hazard Survey 1972–1974.

TABLE 11
Estimated Percentage of Workers Potentially Exposed to Heavy Metals With Periodic Blood or Urine Tests

Agent	Estimated % of Workers	
	Blood Test	Urine Test
Cadmium	14.4	13.4
Mercury	19.4	17.6
Lead	18.4	17.8
All workers	**14.7**	**14.4**

Source: National Institute for Occupational Safety and Health (NIOSH) National Occupational Hazard Survey 1972–1974.

TABLE 12
Estimated Percentage of Workers Potentially Exposed to Noise With Periodic Audiometric Tests

Exposure	Estimated % of Workers
Continuous noise	37.0
Impact noise	17.0
All workers	**21.1**

Source: National Institute for Occupational Safety and Health (NIOSH) National Occupational Hazard Survey 1972–1974.

TABLE 13
Estimated Percentage of Workers Potentially Exposed to Dusts* With Periodic Chest Radiographs or Pulmonary Function Tests (PFT), by Industry Type

Industry Sector	Estimated % of Workers			
	Chest Radiographs		PFT	
	Exposed	All	Exposed	All
Construction	2.0	4.0	1.0	1.8
Transportation/public utilities	43.7	32.7	35.2	12.0
Manufacturing	28.6	35.9	19.1	23.6
Wholesale/retail	16.9	13.9	13.8	4.8
Finance/insurance, etc	0.4	7.3	0.4	1.6
Services	53.8	30.5	14.4	8.1

* One or more dusts of cotton, silica, mica, talc, fiberglass, or coal.
Source: National Institute for Occupational Safety and Health (NIOSH) National Occupational Hazard Survey 1972–1974.

Discussion

Several points may be made on the basis of the findings described above. First, it is clear that the overall prevalence of both preplacement and periodic screening has increased from the 1970s to the 1980s, and that more workers are still required to take preplacement examinations than are given periodic examinations. Sec-

TABLE 14
Estimated Percentage of Workers Potentially Exposed to Heavy Metals With Blood or Urine Tests, by Industry Type

Industry Sector	Estimated % of Workers					
	Blood			Urine		
	Lead	Cadmium	All	Lead	Cadmium	All
Construction	1.1	1.4	11.0	1.1	1.4	1.3
Transportation/public utilities	49.8	62.8	12.2	45.0	55.4	11.9
Manufacturing	23.7	21.1	24.1	23.4	19.8	24.6
Wholesale/retail	1.6	1.8	5.9	1.6	1.6	5.5
Finance/insurance, etc	*	*	1.6	*	*	1.0
Services	9.5	1.0	13.7	8.6	1.0	11.0

* Less than 0.5%.
Source: National Institute for Occupational Safety and Health (NIOSH) National Occupational Hazard Survey 1972–1974.

ond, workers in small plants (those with fewer than 100 employees), who, nevertheless, constitute about one third of the total work force, are still considerably less likely to have medical screening programs than those in large plants. There is also a marked variation in screening among different industries. Furthermore, at least at the time of the first survey, there is no consistent evidence that workers potentially exposed to the agents described are more or less likely to be given appropriate periodic tests than all workers in plants of a given size and industry type. Although the extent of actual exposure was not quantified in either the NOHS or NOES, it undoubtedly varies in different industries and workplaces of different sizes. However, it is not apparent that this variation in exposure explains the observed variation in the provision of tests for potentially exposed workers. No a priori evidence suggests that the levels of hazardous exposures are lower in small plants. On the contrary, because such plants also have fewer industrial hygiene practices in place, the levels are probably higher. Further, it is unlikely, for example, that construction workers potentially exposed to dusts are less exposed than those in wholesale and retail work. However, only 1% of the construction workers have pulmonary function tests, whereas 14% of the wholesale and retail workers do. The data suggest that, with some exceptions, the probability of having specific tests reflects other factors which determine the overall frequency of screening in a given industry or size of plant.

It has been argued elsewhere[4] that to date no recognized framework exists for occupational screening in the prevention of work-related disease. In other words, programs have been developed without a recognized set of objectives and without prior evaluation of the effectiveness of the tests employed. A set of principles for occupational screening programs has been proposed which calls for the implementation of appropriate exposure-specific tests that are effective in terms of their sensitivity, specificity, and predictive value.[4] These principles also take the premise that medical screening should be considered a secondary form of prevention in the lines of defense against known occupational disease. Primary prevention has been defined as the control of hazardous substances in the workplace through the mechanisms of premarket testing, product substitution, engineering controls, industrial (and biological) monitoring, and personal protective equipment, in that order. Finally, it has been stated that the screening program should be instituted only where methods for the primary prevention of occupational disease are in place.

The data presented above indicate that although the overall use of certain primary prevention measures has increased, namely, environmental monitoring and personal protective equipment, still less than a fifth of workers are employed in plants with on-site hygiene and safety personnel. Some evidence from the first NOHS suggests a link between industrial hygiene protection and medical screening, but only in the case of preplacement screening. Analysis of data from the second survey is in progress to determine whether this observation is still valid.

The assumption is not being made a priori that the types of periodic screening tests recommended for specific exposures and examined here are necessarily appropriate or should be instituted for all potentially exposed workers. Equally, the screening practices currently employed cannot be assumed to be effective in, or even directed towards, the prevention of work-related disease. Howe[6] has delineated a number of factors that may influence a company's decision to provide a medical surveillance program and the specific tests that it comprises. Insofar as the employer incurs costs with respect to health insurance claims and benefits, workers' compensation insurance, sickness and accident benefits, and loss of work days due to illness and injury, the economic incentive exists to provide on-site occupational health programs, irrespective of any regulatory requirements. Indeed, there is evidence that a predominant rationale behind the implementation of screening programs is to reduce employee illness costs by selecting employees through preplacement examinations and by using health maintenance and promotion programs (which may include periodic screening tests) to prevent and treat nonoccupational as well as work-related illness.[7] The fact that more workers have preplacement than periodic examinations and the absence of a consistent relationship between potential exposures and screening tests tends to support this evidence. Further, the marked differences in screening prevalence among different industries and plant sizes clearly points to economic factors as the predominant influence on this distribution.

In conclusion, therefore, the data presented here sug-

gest that, at least at the time of the first NOHS, factors other than hazardous exposures are major determinants of who is screened and who is not, supporting the view that a set of guidelines for occupational screening, such as those proposed, should be implemented as part of the process of effectively preventing occupational disease.

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Failure in American Salesmanship

Through years of postwar austerity, and then tempted by Hollywood's visions of the American Dream, Europeans thought America chic, a place—an Eden—lavishly endowed. American cars, those pink Caddies and chromed T-birds, were the shining essence of the dream. And then, mysteriously, the adoration went into reverse. The German road car, the Italian purse, the French designer cheese, these were suddenly chic.

The influx of American tourists to Europe were the carriers of the spore, but Madison Avenue colluded with the myth. Advertisers collected Volkswagen and Volvo accounts and boosted English gin and Scotch whiskies. Ironically, a Caddie or T-bird retains its mystique in London. Parisian jet-setters believe American-made Levis are far better than the same garments made in Europe.

What seems singularly to have failed to happen is for the United States to have sold its own mystique in the way that others have sold theirs. You cannot reduce the trade deficit by selling a Chevy if it isn't competitive with a Honda, but you can more surely begin reversing the flow by exploiting the foreigner's love affair with things American. It's still there, but not exploited.

The bottom line appears to be a failure of salesmanship. The great American gift for hype has been too inwardly directed, prepared to sell other people's snake oil but not native brands. It's time to cut the mustard, and *not* the Dijon.

—From "When Will America Market Its Mystique?"
by Clive Irving in *The New York Times*, July 26, 1986.