Introduction

Located in Southeastern Asia, Taiwan has a population of 22 million and a workforce of more than 9 million as of 1998. During the past 45 years, Taiwan’s industrialization has achieved an average gross national product (GNP) growth rate of 8.8%. Industries in Taiwan have gone through major changes from coal and gold-copper mining since the early twentieth century to agriculture in the 1950s to 1960s, and to manufacturing, commerce, and services since the 1970s as a result of industrial modernization. This can be shown by a recent manpower survey of employed workers in Taiwan (Table 1) [1]. In December 1998 the total work force was 9.34 million persons; of these, 6.53 million were employed by any employer(s). The main health payer for workers, the Bureau of Labor Insurance, has 7.59 million persons insured. Of work-age people, 58.2% participated in productive work (men 70.4%, women 46.1%). The unemployment rate was 2.93%. The patterns of manufacturing industries were also transformed at least partially from labor-intensive industries to technology-intensive industries.

In the process of industrialization, numerous kinds of toxic substances entered into our work environment, and many production processes without adequate safety consideration were also established in factories of Taiwan. The lack of knowledge or recognition of occupational hazards, poorly implemented industrial hygiene measures, and the lack of preemployment and periodic health monitoring have led to rampant occupational injuries and diseases.

Most industries in Taiwan are of relatively small scale. In 1998, approximately 80% of the registered manufacturing industries had fewer than 30 employees, 15% had 30–99 employees, and only 5% had more than 100 employees [2]. This significantly reduced the effectiveness of governmental enforcement of occupational safety and health (OSH) as well as the rate of OSH inspections.

Legal framework for occupational medicine

The Labor Safety and Health Law was enacted in 1974 in Taiwan. The purpose of this law was to “prevent occupational hazards, ensure workers’ safety and health” and that “employers should conduct periodical health examination for workers, and establish worker’s health examination data books while employment starts in ‘especially hazardous operations’.” The ‘especially hazardous operations’ include work conditions in which workers are potentially exposed to high temperature, noise, ionizing radiation, pressure, lead, tetraalkyl lead, 1,1,2,2-tetrachloroethane, carbon tetrachloride, carbon disulfide, trichloroethylene, tetrachloroethylene, dimethylformamide, n-hexane, benzidine, dichlorobenzidine, beryllium, vinyl chloride monomer, benzene, 4-aminodiphenyl, 4-nitrodiphenyl, beta- and alphaphthalalime, toluene diisocyanate, methylene bisphenyl isocyanate, isophorone diisocyanate, asbestos, arsenic, manganese, phosphorus, and paraquat. Labor Standard Law states, “The employers are responsible for preventing occupational hazards, and establishing adequate work and welfare facility for their employees.”
The Labor Health Protection Act mandates the appointment of 1 full-time physician or equivalent for a workplace with 1,000 employees or more; 2, for 3,000 employees or more; and 3, for 6,000 employees or more. For a workplace with 300 employees or more the establishment of a health unit with at least 1 nurse and a part-time physician is required.

In many Western countries, labor unions play an important role in monitoring of workplace safety and health. Few of the labor unions in Taiwan take the role of a complete counterpart to the employers. Many of them are under some extent of employers’ control in various formats, as the statute requires that every member in the labor union must also be an employee of the company. Thus, for any union activity during regular work hours, the union must obtain permission from the employer. Moreover, employees of small factories usually look forward to becoming an independent employer someday. Therefore, there is practically low incentive and priority for union leaders to promote occupational safety and health, the exception being those who have been victims of occupational injuries and diseases.

### Governmental agencies

The governmental agencies most responsible for occupational safety and health are the Council for Labor Affairs (CLA) and the Department of Health (DOH). Their responsibilities and activities are summarized as follows.

#### The Council of Labor Affairs

Under the direct purview of the CLA are the following departments, which oversee specific aspects of labor affairs: Labor-Management Relations, Labor Conditions, Labor Welfare, Labor Insurance, Labor Safety and Health, Labor Inspection, Research and Planning, and Statistics, as well as an Appeals Committee, a Data Information Center, the Employment and Vocational Training Administration, and the Institute of Occupational Safety and Health. The CLA also coordinates all the regional departments and bureaus of labor affairs at the provincial/municipal and county/city government levels. According to the legislation and the policy, the responsibility and activities of the CLA have been as follows.

### Labor safety and health

**Active campaigning for occupational safety and health**
The CLA has launched the Occupational Safety and Health Improvement Program, the Zero Accident Campaign, and other measures to improve occupational safety and health conditions. Their implementation could have contributed to the decrease observed in the overall rate of occupational accidents and injuries over the past two decades [3]. The need for further reduction in the rate of accidents is recognized by the council, since the figures remain much higher than those recorded in other developed countries. To further promote occupational safety and health and to increase industrial productivity the CLA accordingly develops a “Workers’ Safety Upgrading Scheme” with the aim of rapidly reducing occupational accidents and protecting workers’ health. Recently, promotion of Material Safety Data Sheets for chemicals used in the workplaces was adopted as one important approach to enhancing workers’ right to know about hazardous chemicals.

**Promotion of participation in OSH programs and self-management from the industries**
The Council started in the 1990s to facilitate self-management of OSH in enterprises and to assist the establishment of labor safety and health promotion organizations at each work site. On-site accident-prevention and safety and health promotion by the employers and the workers has become a more regular consideration, especially in large industries. In other words, the government policy on OSH moves in the direction of a role of more supervision rather than inspection.

**OSH education**
The Council has been responsible for supervising industries in their accident-prevention training and education for new and transferred workers, occupational safety and health personnel, and workers in high-risk industries. Training programs for prevention of falls and for fire and explosion prevention have been given to selected industries with elevated risks. Qualification examination for certified industrial hygienists was adopted in 1979 in Taiwan. In the 1990s, safety and health

### Table 1 Distribution of the work force of Taiwan as of December 1998 [1]

<table>
<thead>
<tr>
<th>Category</th>
<th>Number of workers (x1,000)</th>
<th>Percentage of total work force</th>
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<tbody>
<tr>
<td>Agriculture, forestry, fishing, animal husbandry</td>
<td>833</td>
<td>8.9%</td>
</tr>
<tr>
<td>Industry</td>
<td>3,465</td>
<td>37.1%</td>
</tr>
<tr>
<td>Mining, quarrying</td>
<td>12</td>
<td>0.1%</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>2,586</td>
<td>27.7%</td>
</tr>
<tr>
<td>Electricity, gas, water</td>
<td>34</td>
<td>0.4%</td>
</tr>
<tr>
<td>Construction</td>
<td>833</td>
<td>8.9%</td>
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<tr>
<td>Commerce</td>
<td>2,096</td>
<td>22.4%</td>
</tr>
<tr>
<td>Transport, storage, communication</td>
<td>487</td>
<td>5.2%</td>
</tr>
<tr>
<td>Service</td>
<td>2,148</td>
<td>23.0%</td>
</tr>
<tr>
<td>Finance, insurance, real estate</td>
<td>400</td>
<td>4.3%</td>
</tr>
<tr>
<td>Business services</td>
<td>270</td>
<td>2.9%</td>
</tr>
<tr>
<td>Social, personal, and related community service</td>
<td>1,478</td>
<td>15.8%</td>
</tr>
<tr>
<td>Public administration</td>
<td>311</td>
<td>3.3%</td>
</tr>
<tr>
<td>Total</td>
<td>9,340</td>
<td>100.0%</td>
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</table>
education has become mandatory in subcollege professional schools, vocational schools, colleges, and vocational training organizations. Information on OSH has been disseminated through programs regularly offered via television media and an exhibition truck going from school to school.

Labor inspections

The scope of labor inspections encompasses the legal requirements of the Labor Inspection Law, Labor Safety and Health Law, Labor Standard Law, Labor Insurance Law, Labor Welfare Law, Employment Service Law, and other related legislation. The purposes of labor inspections are to supervise enterprises such that they obey labor laws, to make the workplace safer and more comfortable, to rationalize labor conditions and scheduling, to prevent occupational accidents, and to reduce disputes between labor and management. Potentially hazardous and injury-prone workplaces are priority sites for the inspection. Due to the shortage in manpower of labor inspectors, large-scale enterprises are more likely to be inspected than are smaller industries. During inspection, an item-by-item check of the worksite OSH condition, including industrial hygiene measures, exposure levels to hazardous chemicals, and records of periodic physical examination of the employees, is most frequently conducted. Special attention is paid to workers' complaints. Good record-keeping is stressed for accidents, workplace sampling data, and health examination data. The inspectors can also encourage enterprises to create their own safety and health management system. Recently, enterprises have been encouraged to develop programs for self-inspection of OSH.

Policy for foreign workers

Since the late 1980s, foreign workers have been brought into Taiwan on a short-term basis (2 years per worker as a general rule) from Thailand, Malaysia, the Philippines, and Indonesia for major public construction projects and key manufacturing sectors and as domestic helpers, caretakers, and foreign crews. By September 1998 the number of foreign workers in Taiwan had exceeded 260,000. Policies on foreign workers in Taiwan uphold the principles of supplementing the local work force instead of replacing it. The Council has been actively conducting OSH training and education for foreign workers.

The Department of Health

The Bureau of Health Promotion of the Department of Health (DOH) is responsible for promotion of occupational health and prevention of occupational diseases. Major activities implemented by the DOH include the following.

Provision and facilitation of services in the prevention and control of occupational diseases

Strategies on occupational health have been formulated for health bureaus to implement. Health workers from local health bureaus pay regular visits to industrial sites to conduct health education and OSH counseling. Results of all workers' health examinations are collected and inspected in the health bureaus. Sentinel health events are identified for further action, including a site visit, counseling, and initiation of labor inspection, by notification of the CLA.

To make medical care more available to the workers, major teaching hospitals have been encouraged to set up special clinics for occupational medicine. Currently, approximately 30 medical care institutions have such clinics. Centers for Occupational Diseases Control (CODC), sponsored by the DOH, have been established in six universities for counseling, teaching, training, and research in occupational health for both specialists and the industries. Close cooperation between these centers, district and local health bureaus, and special clinics for occupational diseases in the teaching hospitals in their respective areas is maintained to formulate a service network.

Establishment of surveillance systems for occupational diseases

To overcome the problems of underestimation of the prevalence and incidence of occupational diseases and injuries [4] in Taiwan, the DOH launched an occupational disease surveillance system as an effort to document the profile of occupational diseases in the 1990s, using the successful models of surveillance systems used for reportable and communicable disease in the past. Entitled the “Program to Reduce Exposure by Surveillance System” (PRESS), this system has extended its target to workers' blood lead levels (PRESS-BLLs), noise-induced hearing loss (PRESS-NIHL), and work-related diseases (PRESS-WORD) [5].

PRESS-BLLs was initiated in 1992, when the DOH recognized a serious lead-poisoning problem in workers and children in a nearby kindergarten [6] and started a laboratory-based blood-lead-level surveillance system [7]. The preparation efforts of this system included determination of the background blood lead levels in the general Taiwanese population [8], evaluation of the intra- and interlaboratory variation in blood lead measurements, and a site visit to all blood-lead laboratories for quality control/quality assurance [9]. Symposiums were held to discuss lead toxicity and the quality control/quality assurance of blood lead measurement in 1992 and 1993. Annual measurements of the blood lead level
(BLL) are required by the Labor Safety and Health Law for lead workers. Up to December 1997, the DOH has information on more than 20,000 BLLs and workers' health information along with coverage of more than 80% of workers exposed to lead. Many high-risk workplaces have been identified, and approximately one-tenth of lead-exposed workers have been found to have BLLs exceeding the reporting values (≥ 40 μg/dl in male workers and ≥ 30 μg/dl in female workers). Education was given to the employers and employees in workplaces where clusters of high BLLs were found. An evaluation program for this surveillance-oriented intervention strategy has been developed, and the eradication of lead poisoning is projected for the year 2005.

A similar approach was used in PRESS-NIHL. Annual audiometric examination had been required for workers exposed to noise levels of > 85 dBA, but without adequate monitoring of the quality of the examination. PRESS-NIHL was started by inspection, testing, and standardization of the performance of audiometric units in the examining hospitals. A total of 73 audiometric examination units were qualified, and these units periodically report audiograms and other related information of workers to the DOH. Up to December 1997, more than 70,000 audiograms have been collected. Of these, >30% were found to indicate a hearing loss of > 40 dB at the frequency of 4 kHz and > 20%, a loss of > 55 dB. Workers with the latter condition were considered as suffering from occupational noise-induced hearing loss. These findings from PRESS-NIHL indicate that the current standard of 90 dBA for 8 h might not be sufficient to protect noise-exposed workers from hearing loss. Intervention strategies for hearing conservation are urgently needed.

Different from the laboratory-based system and mandatory examination involved in PRESS-BLLs and PRESS-NIHL, PRESS-WORD, started in 1995, has depended mainly on the 6 CODCs, teaching hospitals with occupational medicine clinics, and the previously established reporting system for reportable and communicable diseases in Taiwan, with approximately 1,000 physicians participating around the whole country. Suspected work-related diseases reportable under PRESS-WORD include heavy-metal poisoning, gas and vapor poisoning, decompression sickness and hyperbaric trauma, dermatitis, trauma, noise-induced hearing loss, pneumoconiosis, carpal tunnel syndrome, pesticide poisoning, and other occupational and environment-related diseases. Monthly review of reported cases is held by an expert committee. Field survey, case management and follow-up, health education, and worksite intervention are four major components constructing the framework of PRESS-WORD. Up to June 1998 a total of 6,970 suspected occupational diseases were reported and 10 worksite clusters with severe occupational health problems that required urgent management were identified. This system, although highly dependent on the interest and specialities of the reporting physicians, provides evidence that the numbers and rates established for occupational diseases by records of workers’ compensation have been severely underestimated.

Quality control of health examination for workers

Preemployment and periodical health examinations are required for workers. In workers involved in the enlisted “especially hazardous operations,” special items of examination are required. Hospitals performing health examinations for workers have to go through regular accreditation and supervision by the DOH. More stringent criteria are applied to hospitals conducting “especially hazardous operations.” A Physician’s Manual on Health Examination for Workers has been developed, in which guidelines for reading of examination results are included. Examining hospitals are also requested to develop a set of guidelines for quality assessment of the health examinations for workers. Quality-control processes for blood-lead measurements were launched for the laboratories in medical institutions that conducted such analyses. Meetings among employers, plant OSH personnel, and representatives of health examining institutions are held regularly by the DOH and the CLA.

Education and training on occupational health

OSH education at the worksite is conducted by public health workers from local bureaus of health in a regular basis. Continuing education for health workers is given in the workshop format at least yearly. For physicians and nurses, workshops on occupational health are held and are included in the continuing education for their professions. In addition, academic institutions have been subsidized for the organization of annual conferences for the exchange of information on occupational health. Many of these workshops and conferences are jointly sponsored by the DOH and the CLA.

Health surveillance of foreign workers

The increasing number of foreign workers mandates vigorous OSH measures. For disease control the Guidelines Governing the Permission for and Management of Foreign Workers stipulate that every foreign worker be required to undergo one physical examination before entry, within 7 days after entry, after every 6 months of employment, and before the renewal of their contract. On the other hand, foreign workers have to adapt to different cultures, languages, work methods, and psychological strains and can thus be at higher risk for occupational injuries and illnesses. An active monitoring program was recently launched for the OHS status of foreign workers in Taiwan [10].
Profile of and statistics on occupational diseases

Statistics of occupational injuries and diseases

The annual incidence of compensated occupational diseases in Taiwan is much lower than that reported in selected developed countries (Table 2) [11–15]. This is most likely secondary to the relatively small number of occupational physicians and the lack of training and motivation of practicing physicians for the diagnosis of occupational diseases rather than to better OSH conditions in Taiwan as compared with these developed countries. This is supported indirectly by the much higher mortality rates recorded due to injuries in manufacturing workers in Taiwan (Table 3) as opposed to those countries. Although the incidence rates of, and the disability secondary to, occupational injuries have been reduced in the past decade, they are nonetheless much higher in Taiwan than in selected developed countries. Many of the cases in the following sections documented in the literature were not compensated [16].

Occupational lung diseases

Pneumoconiosis was the oldest and most well-known occupational lung disease in Taiwan. Since 1954, when the first six cases of pneumoconiosis were documented in the Chinese literature in Taiwan, the diseases caused by dusts had caused significant concern at the CLA. Many surveys were focused on dust-induced diseases, mainly silicosis and coal-miner’s lung. Silica-contained minerals were mainly used in Taiwan for the manufacture of pottery, refractories, cement, and glass and in foundries and the steel industry. The total morbidity was high in cement and refractories product workers [13]. Asbestos has been used in Taiwan for more than 30 years, including in ship-stripping, which also started 30 years ago. However, only a few cases of asbestosis were documented from a shipyard and one asbestos-cement manufacturing factory. Diagnosis of more cases of asbestosis and asbestos-related cancer are expected in the near future because of increasing awareness and due to the long latent period. No case of talcosis has been documented.

Patients with occupational asthma are rather frequently seen in Taiwan. Cases of toluene diisocyanate- and diphenylmethane diisocyanate-induced asthma were found in plastics-manufacturing workers and Velcro-like tape-manufacturing workers [17]. All of these cases were confirmed by provocation test or detailed clinical evaluations. There were domestic reports of byssinosis in cotton-dust-exposed quilt makers and cotton textile

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Table 2 Comparison of the incidence of occupational diseases among countries

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<tr>
<td>Skin</td>
<td>58,200</td>
<td>111</td>
<td></td>
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<tr>
<td>Respiratory</td>
<td>20,800</td>
<td>9</td>
<td>366</td>
<td>1,584d</td>
<td></td>
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<tr>
<td>Cumulative trauma</td>
<td>223,600</td>
<td>4</td>
<td>506</td>
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<tr>
<td>Physical agents</td>
<td>18,200</td>
<td>1,153</td>
<td></td>
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<tr>
<td>Hearing loss</td>
<td>3,207</td>
<td>1,302</td>
<td></td>
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<tr>
<td>Poisoning or intoxication</td>
<td>6,700</td>
<td>4,460</td>
<td>67</td>
<td>182</td>
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<td>Work stress</td>
<td>29,541</td>
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<td>Cardiovascular or cerebrovascular</td>
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<tr>
<td>Other diseases</td>
<td>40,800</td>
<td>2,199</td>
<td>28</td>
<td>60</td>
<td>109</td>
</tr>
<tr>
<td>Total workers</td>
<td>368,300</td>
<td>40,560</td>
<td>1,521</td>
<td>1,529</td>
<td>1,754</td>
</tr>
<tr>
<td>Annual incidence per million employees</td>
<td>4,066</td>
<td>10,100</td>
<td>870</td>
<td>206</td>
<td>36.5</td>
</tr>
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Table 3 Comparison of mortality (per million workers) due to occupational accidents among selected countries

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<td>1993</td>
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Footnotes:
- a Diseases were categorized differently in different countries
- b Only from nongovernmental enterprises, not including industries with fewer than 11 employees or self-employed workers
- c Employed persons aged 15 years and over
- d Mainly due to pneumoconiosis
- e Mainly due to vibration-induced diseases
workers. Despite the exposure of many farmers to grain dust, hypersensitivity pneumonitis has never been documented, most likely due to a lack of knowledge and of convenient diagnostic tools.

Intoxications resulting in chemical pneumonitis, pulmonary edema, and casualties caused by leakage of toxic gas or vapor from industrial settings have been rather frequent in Taiwan. The documented causative agents include carbon monoxide, hydrogen sulfide, ammonia, chlorine, hydrocarbons, mercury vapor, and polytetrafluoroethylene.

Occupational liver diseases

Cases of toxic hepatitis induced by 1,1,2,2-tetrachloroethane and carbon tetrachloride have been documented in an electronic assembly factory and color printing factories [18]. Dimethylformamide (DMF)-induced toxic hepatitis was also found in synthetic leather-manufacturing workers [19]. Cases of chloroform-induced toxic hepatitis have been seen among pencil-sharpening assembly workers. Occupation-related angiosarcoma of the liver has not yet been documented in workers exposed to vinyl chloride monomer (VCM). However, an increased frequency of hepatoma has been found in these workers, especially among those with a hepatitis B carrier status [20]. The lack of pathological examination of the liver tumor due to a reluctance to autopsy and the high incidence rate of hepatoma in the general Taiwanese population have made the confirmed diagnosis of angiosarcoma extremely difficult.

Health care workers in Taiwan are known to be at high risk for needle-stick injuries [21]. With a high background rate of hepatitis B and C carriers, hepatitis secondary to work exposure to body fluid can be significant. Fulminant hepatitis has been seen in health workers accidentally exposed via needle-stick injuries.

Occupational neurological diseases

Several outbreaks of toxic polyneuropathy have been documented in Taiwan in the past 10 years. The causative agents included n-hexane, lead, and carbon disulfide. Two outbreaks of n-hexane intoxication with severe polyneuropathy have been documented within an interval of 3 years in the press-proofing factory of a color printing factory and in a ball-manufacturing factory [22]. Nerve-entrapment diseases, especially carpal tunnel syndrome, induced by repeated movements is among the occupational diseases most frequently reported in PRESS-WORD. Many patients with clinical symptoms resembling parkinsonism have been documented in ferromanganese smelting industries, showing the signs of masking face, bradykinesia, cogwheel rigidity, and tremor during handwriting [23]. These patients were more resistant to therapy with levodopa than were patients unexposed to manganese.

Occupational hematological diseases

Only a few cases of aplastic anemia have been documented as being caused by occupational benzene exposure in Taiwan. Cases of lead poisoning manifesting with anemia have rather frequently been seen in Taiwan in adults and children. Causes of lead poisoning include working at battery, tile, and metal recycling industries and herbal medicine use. Three cases of methemoglobinemia induced by aniline dye exposure have also been documented; however, all the methemoglobin levels measured in the blood were <30%.

Occupational dermatitis

Irritant dermatitis was found in pulp mill workers, organic solvent-exposed workers, hairdressers [24], and kerosene-exposed ball-bearing factory workers [25] in Taiwan. Allergic dermatitis was documented in cement, photogravure, leather, and carbon-fiber racket manufacturing workers as well as mechanics, construction workers [26], and farmers [27]. It was estimated that 21.2–36.6% of cases of contact dermatitis treated in an outpatient clinic was occupational in origin [28]. Among the cases of occupational contact dermatitis, 54–58% involved irritant and 42–46%, allergic dermatitis. The occupations most often afflicted with contact dermatitis include electronics, construction, and printing as well as hairdressing, farming, and medical practice. The common allergens frequently noted in the working environment are chromium, nickel, cobalt, fragrance, formaldehyde, epoxy resin, paraphenylenediamine and eugenol, and organic mercury.

Occupational musculoskeletal disorders

Although musculoskeletal diseases and disabilities secondary to these problems are among the most common occupational health hazards in many developed countries, information concerning these conditions is limited in Taiwan. Up to 1998, none of the chronic musculoskeletal diseases or cumulative trauma injuries has been compensated by Workers’ Compensation.

Occupational cardiovascular diseases

Cardiovascular diseases are usually not considered as occupational diseases and are not compensated in Taiwan.

Occupational heavy-metal poisoning

Lead poisoning has been among one of the occupational diseases studied most thoroughly in Taiwan. Workers have been reported to be exposed to high levels of lead in lead smelting, lead-battery manufacturing and recycling,
workers. Ingestion have been reported in spraying or manufacturing conditions in farmers is pesticide poisoning. Since the introduction of organophosphate pesticide in Taiwan in 1953, many cases of organophosphate pesticide poisoning have been reported. Mercury intoxications causing central neuropathy and chemical pneumonitis have been reported. Chromate-induced nasal septal perforation and dermatitis in an electroplating factory has also recently been documented.

Occupational cancers

Large-scale population studies of mortality due to cancer have been lacking in Taiwan. The development of Bowen’s disease in paraquat manufacturing workers was reported [29]. A case of lung cancer occurred in the topside worker of a coke oven; he was compensated by the company because of the 8-year induction period but did not receive compensation from Labor Insurance.

Agricultural workers are known to suffer from a multitude of occupational diseases and injuries. However, these problems have largely been overlooked in Taiwan because of the general concept in the health and safety authorities that OSH mainly concern industries, especially employed workers. Few reports are available on the pattern and magnitude of occupational injuries and diseases among agricultural workers. One of the most striking ailments secondary to occupational conditions in farmers is pesticide poisoning. Since the introduction of organophosphate pesticide in Taiwan in 1953, many cases of organophosphate pesticide poisoning have been reported in spraying or manufacturing workers.

**Occupational medicine education and training**

Medical education

As of 1998 there are nine medical schools in Taiwan. Most of them include environmental and occupational health in their didactic teaching during premedical years (the first 2 years of the 7-year medical school program) and as part of the public health curriculum. Didactic courses on clinical occupational and environmental medicine are either lacking or offered as electives. Clinical rotations in occupational and environmental medicine are uncommon.

Graduate medical education

Up to October 1998, guidelines had not been established for graduate training at the national level. In all, 13 teaching hospitals in Taiwan providing official residency training for occupational medicine were accredited by the Environmental and Occupational Medical Association, a nongovernmental organization. Accreditation procedures for these teaching hospitals were started in 1997, which put greater emphasis on the qualification and staffing of the teaching hospitals and less emphasis on the program per se. Training programs in different teaching hospitals therefore varied significantly. As of October 1998, eight medical graduates were in active training in these residency programs. The major reasons for the low incentive among medical graduates include the lack of an officially certified occupational medicine board, the lack of recognition of occupational medicine as an independent medical specialty or subspecialty, the limited numbers of staff positions in teaching hospitals, and the lack of comprehensive reimbursement programs for the evaluation, diagnosis, and treatment of occupational diseases.

To prevent a shortage of occupational physicians, several colleges or institutes of public health in Taiwan offer a 2-year Master’s degree program in occupational medicine as a means of encouraging education and training in this field. In addition, a short-course training program is designed by the DOH to provide continuing education in occupational medicine for medical graduates. At the end of the 240-h training period a medical doctor who has finished this program is entitled to provide diagnosis and treatment for occupational diseases and is certified as “Doctor for Occupational Diseases Diagnosis and Therapy” (DODDT). Other eligibility criteria for DODDT certification include any one of the following: (1) being Occupational Medicine Board-certified by either of the two medical associations or by selected developed countries providing such certification; (2) completion of graduate study with a Master’s (generally 2 years didactic and thesis in Taiwan) or Doctoral degree in occupational medicine; (3) having been trained in any of the occupational medicine residency programs for 1 year plus 120 h of a short-course occupational medicine training program; or (4) board certification of another specialty plus 240 h of a short-course occupational medicine training program. Applicants will be reviewed by a committee to determine the qualification. Up to October 1998, a total of 138 physicians were certified by the DOH as DODDT. Physicians and surgeons certified as DODDT are entitled to receive double payment of their physician fees from the laborer’s insurance instead of from the universal health insurance, the National Health Insurance Program, during the first four visits of any patient with suspected occupational disease with written documentation. Certification as a DODDT is not a requirement for the performance of preemployment or periodical health examinations for workers, for the practice of occupational medicine, or for the diagnosis of occupational diseases.

**Activities of occupational physicians**

Two nongovernmental organizations, the Association of Occupational Medicine (AOM) and the Environmental
and Occupational Medical Association (EOMA), are currently actively involved in occupational medicine. They also evaluate the credentials of and certify physicians in occupational medicine.

The AOM was established in 1978 with the goals of "promoting occupational health and preventing occupational diseases." Currently the AOM enrolls approximately 1,000 members, and 210 of them have been board-certified by the Association. It constantly provided a short-course occupational medicine training program in 1995–1998. Many practicing physicians and industrial doctors joined this association to acquire further training and education in occupational health and related knowledge in public health.

The EOMA was established in 1992 with the goals of "promoting occupational and environmental health and facilitating the advances of occupational and environmental medicine." Currently the EOMA enrolls more than 250 members, and approximately 100 of them have been board-certified by the Association. It collaborates with the six Centers for Occupational Medicine as well as with universities in several current research projects, and it jointly holds a yearly national occupational health conference with the Association of Occupational Hygiene and the Association of Occupational Health Nursing.

The board-certifying examinations for both associations include both a written examination and an interview for the discussion of clinical cases, the industrial scenario, and the diagnosis and management of patients. For a physician to be allowed to take its certifying examination ("board eligibility") the EOMA requires an active medical license, 2 years of clinical residency training in one of several clinical specialties such as internal medicine, family medicine, and orthopedics, plus a 2-year master’s program or residency training in occupational health or the equivalence thereof. AOM’s requirements for board eligibility are similar to the requirements for DODDT. One of the differences between these two associations is that AOM does not require a medical graduate diploma. This is related to the historical background of Taiwan. Back in 1949, many military health service professionals with varying medical backgrounds came to Taiwan with the KuoMinTang government from mainland China; for them the recovery or reissue of their medical diploma became difficult, if not impossible, due to the political separation represented by the Taiwan Strait. Training courses and special examinations were given to them for certification of the license to practice medicine. Some of these people became industrial doctors, who joined the AOM during the past two decades.

That board certification is conferred separately by two associations, the EOMA and the AOM, actually made official recognition of the board of occupational medicine from the DOH more difficult to obtain. Although the DOH has recognized board certification for the other 19 medical specialties, the board of occupational medicine had not been officially recognized by the DOH in 1998.

As mentioned above, the diagnosis of occupational disease or the documentation of its work-relatedness in Taiwan has been severely limited. Several factors might have contributed to this situation:

1. The capability of physicians to diagnose occupational disease: the number of occupational physicians has been relatively small, and the training for the diagnosis of occupational diseases has been lacking in physicians in general practice.

2. The deficiency of reasonable compensation in occupational medicine: a medical legal report is considered a regular diagnostic documentation and is compensated accordingly (in 1998, less than U.S. $20). Although the complete recording of the work history and a worksite inspection are frequently required for the correct diagnosis of occupational diseases, the time required by the physician for this activity is not compensated. The potential time consumed in association with litigation while a diagnosis is being made is not compensated. It is considered a civil responsibility to be an expert witness in court. This greatly adds to the reluctance of physicians to diagnose occupational diseases.

3. The exclusion of musculoskeletal and connective tissue diseases from consideration as occupational diseases: the most common occupational diseases in developed countries, musculoskeletal and connective tissue diseases, had been excluded from the occupational disease benefit payment before 1998. Most of these diseases occurred in persons involved in unduly heavy physical work, carrying heavy loads and assuming an inappropriate posture, which were as commonly seen in Taiwan as in many other countries. However, the list of occupational diseases newly revised in 1998 includes most of the musculoskeletal diseases listed in the table published by the European Union. Although this will likely increase the diagnosis of occupational musculoskeletal diseases, the true impact remains to be determined in the next few years.

4. The short statute for worker’s compensation claims: the statute for a claim of worker’s compensation payment was limited to 2 years before 1998. Since many occupational diseases developed after workers’ leaving work or were diagnosed at 2 years or more after medical leave, the workers could not receive benefit payments from the Bureau of Labor Insurance. In 1998, the within-2-years statute was modified, and compensation for pneumoconiosis can be received beyond 2 years and after retirement.

5. The general lack of knowledge about occupational disease in employers and employees: this, in combination with the above, results in the worker’s seeking medical attention from nonoccupational physicians who have limited training in occupational medicine and only a negative incentive, if any, for occupational disease diagnosis. In rare cases, if this diagnosis is made, the physician will have to go through considerable paperwork, which is cumbersome and nonreimbursed, and take the risk of being taken to court by the patient’s employer as a witness, or even a defendant, in court.
Up to the year 1998, not a single clinic or hospital had been designated mainly for the care of patients with occupational diseases in Taiwan. In most of the occupational medicine clinics in teaching hospitals the majority of disease cases are nonoccupational. Periodic and preemployment health examinations have been one of the most important activities of occupational physicians in many developed countries. In Taiwan, such examinations do not require the presence of an occupational doctor for the examination, history taking, or reviewing of the results. Qualification of these examinations is currently under active surveillance by the DOH. The job mobility of Taiwanese workers is great, and most employers do not keep health records, including health examination records, on their workers. This makes the tracking of changes in health or disease status in workers difficult for occupational physicians.

**Research in occupational and environmental medicine**

Public health workers in Taiwan have participated in more than 100 peer-reviewed publications in occupational medicine during the last 5 years. This number is approximately 2-fold that of the previous 5 years, indicating increasing emphasis on and effort in this discipline. The main research areas were epidemiology and surveillance, clinical toxicology, and industrial hygiene, and there has recently been an increase in biomarker and susceptibility studies. Research is conducted mainly in the universities and research institutions mentioned above. Research within clinical departments of occupational medicine and occupational health services is rather limited. The major sources of funding for OSH research include the Bureau of Biomedical Science of the National Science Council, the Institute for Occupational Safety and Health (IOSH) of the CLA, and the DOH.

The goals of the IOSH involve the conduct of research related to OSH. Four main aims were adopted by IOSH in research, occupational safety, occupational health, analysis and exposure-assessment method development, and occupational medicine. Topics in occupational safety research include safety management policy, machine safety, construction safety, electrical equipment safety, chemical safety, personal safety equipment, safety testing equipment, and the study of measuring instruments for occupational safety. Occupational health research topics include disease prevention, hazard identification, preventive technology and strategy, occupational health management and policy, workplace air pollutant control, prevention of ergonomic hazards, survey of toxic chemical exposures at work, and research of hazard prevention strategies. Research directions in analysis and exposure-assessment method development are on-site toxic sample analysis, biological monitoring, exposures in hazardous workplaces, and development of domestically applicable sampling instruments. Occupational medicine research stresses surveillance of occupational diseases and injuries, occupational epidemiology, occupational health promotion, and occupational biomedicine.

Research sponsored by the DOH includes occupational disease surveillance, health education, and health effects by specific factors. In all, 6 centers for occupational health and 30 clinics for occupational diseases have been sponsored by the DOH. Through their efforts, many on-site reports have been published in international journals on occupational and environmental medicine.

Research topics at the Bureau of Biomedical Research, National Science Council, are more flexible and are based more on the researchers’ interest than is the target-oriented research supported by the IOSH or the DOH. To improve the health and welfare of workers and to promote research in occupational and environmental health, the National Health Research Institutes plan to establish a Division of Environmental Health and Occupational Medicine in 1999. It is generally believed that this will bring significant impact to the research in OSH in Taiwan.

**Future prospects**

Industrialization and economic growth have initially caused increasing contact with hazardous working environments and work processes in Taiwan. The resulting prosperity and improved safety and health knowledge arising from the same growth, however, brought significant public understanding and increasing emphasis on OSH. Occupational health has been in a continuing process of evolving over the past 40 years. As seen from the viewpoint of 1998, occupational injury rates remain high, the diagnosis and management of occupational diseases are unsatisfactory, and the knowledge of and attitude toward OSH in employers and employees remain to be improved. An understanding of the domestic problems involved in OSH is lacking in the following general areas: injuries and diseases in agricultural workers, occupational musculoskeletal problems and cumulative trauma diseases, occupational cancers and the susceptibility to cancer, reproductive hazards, and cardiovascular conditions associated with work. The outreach of OSH to small industries, which represent the vast majority of Taiwanese industries, remains a great challenge for public health workers.

Improvement in the following areas will be most significant for OSH in Taiwan:

1. The knowledge of, attitude toward, and perception of OSH in the workplace need be systematically assessed before and after OSH education and other intervention; therefore, better methods will be developed for OSH education. This effort has to cover smaller industries as well as large industries.
2. The mechanisms of workers’ compensation have to be improved such that injured or diseased workers have ready access to compensation.
3. A board of occupational medicine should be officially established to enhance the qualification of occupational physicians. Specialty training programs in occupational medicine should be standardized.

4. The scheme for reimbursement for the clinical evaluation, diagnosis, and management of occupational diseases should be reset such that the occupational physician’s expertise, time, and risk are adequately compensated.

5. Research efforts are especially needed for an understanding of the domestic problems faced by agricultural workers and workers in small industries. Rates, risk factors, and mechanisms of occupational musculoskeletal problems, occupational cancers, reproductive hazards, and cardiovascular conditions should be studied.

6. The quality of workers’ health examinations should be systematically monitored.

7. To help industries conform with the coming trend toward comprehensive OSH in the twenty-first century as proposed in BS 8800 or, possibly, ISO 18000 standards, risk-assessment and management procedures for every unit operation in the life cycle of a product must be adopted and stressed in the future.

With the above effort, we hope that occupational injuries and diseases will be decreased and workers’ health and safety will be further protected.

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