The impact of occupational health service network and reporting system in Taiwan

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Background: Underreporting occupational disease cases has been a long-standing problem in Taiwan, which hinders the progress in occupational health and safety. To address this problem, the government has founded the Network of Occupational Diseases and Injuries Service (NODIS) for occupational disease and injury services and established a new Internet-based reporting system.

Objectives: The aims of this study are to analyze the possible influence of the NODIS, comprised of Center for Occupational Disease and Injury Services and their local network hospitals, on compensable occupational diseases and describe the distribution of occupational diseases across occupations and industries from 2005 to 2010 in Taiwan.

Methods: We conducted a secondary analysis of two datasets, including the NODIS reporting dataset and the National Labor Insurance scheme’s dataset of compensated cases. For the NODIS dataset, demographics, disease distribution, and the time trends of occupational diseases were analyzed. The data of the Labor Insurance dataset was used to calculate the annual incidence of compensated cases. Furthermore, the annual incidence of reported occupational diseases from the NODIS was further compared with the annual incidence of compensable occupational diseases from the compensated dataset during the same period.

Results: After the establishment of the NODIS, the two annual incidence rates of reported and compensable occupational disease cases have increased by 1.2 and 2.0 folds from 2007 to 2010, respectively. The reason for this
increased reporting may be the implementation of the new government-funded Internet-based system. The reason for the increased compensable cases may be the increasing availability of hospitals and clinics to provide occupational health services. During the 2008–2010 period, the most frequently reported occupational diseases were carpal tunnel syndrome, lumbar disc disorder, upper limb musculoskeletal disorders, and contact dermatitis.

Conclusions: The new network and reporting system was successful in providing more occupational health services, providing more workers with compensation for occupational diseases, and reducing underreporting of occupational diseases. Therefore, the experience in Taiwan could serve as an example for other newly developed countries in a similar situation.

Keywords
Occupational disease, Occupational health services, Occupational medicine, Reporting, Surveillance

BACKGROUND

Underreporting of occupational disease

During, 2001–2007, only 300 of the 10 million economically active workers in Taiwan received worker’s compensation from the Bureau of National Labor Insurance for occupational disease each year. The annual rate of compensable occupational disease in Taiwan was approximately 4·4 per 100 000 workers in 2010, much higher than that during the 2001–2007 period, but still much lower than in neighboring countries (albeit with varied definitions of occupational disease), such as Korea (occupational illness: approximately 49 per 100 000 in 2010)1 and Japan (20 per 100 000 workers in 2010).2 This low number is most likely due to underreporting. As in other nations, there are multiple reasons for underreporting.3,4

Innovations in occupational health care delivery and reporting

Occupational health and safety personnel as well as the Council of Labor Affairs have gradually gained an understanding of the severity of under-diagnosis and underreporting of occupational diseases and injuries in Taiwan. Although most medical centers had established occupational medicine clinics to provide occupational health services to workers with occupational diseases or injuries before 2003, the quantity of the services was relatively lower than other medical services within the medical centers, and a pool of associated experts or comprehensive treatment team was not established at that time. Beginning in 2003, the Bureau of Labor Insurance of the Council of Labor Affairs encouraged tertiary referral medical centers to provide comprehensive occupational health services to workers sustaining occupational diseases or injuries through grant support. The National Taiwan University Hospital established the first Center for Occupational Disease and Injury Services (CODIS) in April 2003. Eight other tertiary referral medical centers established CODISs between 2004 and 2008. There are specialists in occupational medicine, occupational health nurses, case managers, industrial hygienists, and occupational therapists in CODISs, and most CODISs belong to the departments of environmental and occupational medicine at the medical centers. In addition, the other medical specialists, special management teams, and other health care providers or experts within the medical centers are available to provide medical services to workers with occupational diseases or injuries through consultation or a combined care mechanism. Three CODISs are located in northern Taiwan, with three in central, two in southern, and one in eastern Taiwan.

In 2007, a coordination center, the Center of Occupational Diseases and Injuries Management and Service, was
established and helped the Council of Labor Affairs to coordinate the CODISs. Starting in 2009, the primary and secondary hospitals in the general catchment areas of the nine CODISs were invited to cooperate with their CODIS. In the local network hospitals, there is generally only one specialist in occupational medicine and no other full-time staff, such as occupational health nurses, case managers, or industrial hygienists. Therefore, each local network hospital should be assigned to one CODIS to cooperate in providing comprehensive services. By the end of 2010, 52 local network hospitals had joined. Thereafter, the nine CODISs and their local network hospitals formed a national service network to provide accessible services for workers with occupational diseases or injuries, which is called the Network of Occupational Diseases and Injuries Services (NODIS) (Fig. 1). Because of an increasing number of participating medical centers and hospitals in the NODIS from 2005 to 2010, the number of weekly outpatient clinics providing occupational health services to workers with occupational diseases or injuries increased from 34 clinics in 2005 to 170 in 2010. After 2009, the number of clinics in local network hospitals surpassed the number at all nine CODISs (97 in all network hospitals and 73 in all CODISs in 2010) (Fig. 2). Therefore, workers with occupational diseases or injuries had easy access to the services provided by the NODIS.

The coverage provided by the NODIS for workers in Taiwan is comprehensive and only excludes one county out of 22 cities or counties. If workers develop an occupational disease, they can easily visit a clinic in the network system within 30 km of their workplaces or homes. The main services of NODIS include diagnosing and managing occupational diseases and injuries, preventing occupational diseases and injuries, rehabilitating and facilitating a return to work, case management, assistance in worker claims for labor insurance, worker education, combined management with relevant specialists or experts, and providing specific occupational health services to enterprises.
Before the implementation of the current occupational disease and injury reporting system, the Department of Health ran a surveillance program for occupational disease and injury from 1995 to 2007.\textsuperscript{5,6} In that system, occupational diseases or injuries were reported by practicing physicians of hospitals and clinics in which occupational medicine clinic was available, and mainly from six medical centers. However, the reporting was through paper reporting, not Internet. With the establishment of the CODIS beginning in 2003, the Council of Labor Affairs encouraged specialists in occupational medicine at medical centers to report occupational diseases and injuries. One center reported in 2003, three in 2004, four in 2005, five in 2006, and seven in 2007. To build a comprehensive understanding of the status and trends of occupational diseases and injuries in Taiwan, a new Internet-based reporting system for occupational diseases and injuries was established in 2007 and maintained by the Council of Labor Affairs with its coordination center. The Council of Labor Affairs entrusted the hospitals or clinics of the NODIS with the contract-based project, with grant support encouraging tertiary referral medical centers to provide comprehensive occupational health services to workers sustaining occupational diseases or injuries. The major differences between the two systems are that, first, the reporters for the new system are specialists in occupational medicine, and second, the new system was Internet-based and contract-based. In addition to reporting, the occupational health specialists could issue the certificate to the workers for the purpose of compensation if Labor Insurance criteria for occupational disease were met.

The definition and classification of reported occupational diseases are based on the rules published by the Bureau of National Labor Insurance, based on Taiwan’s “Regulations for the Examination of Injuries and Diseases Resulting from the Performance of Duties by the Insured Persons of the Labor Insurance Program” and “Labor Insurance Act.” Specialists in occupational medicine can also report diseases not included in the classification system or the list of occupational diseases by the Bureau of National Labor Insurance. If specialists report a disease that is not included in the classification system or the list of occupational diseases, they must provide a justification and cite relevant literatures to support the work-relatedness of the condition. On a quarterly basis, the system will transfer the data from each reported occupational disease case to three senior and experienced specialists in occupational medicine. The specialists then simultaneously review the data according to the same criteria of work-relatedness. Review is double blind and decisions require an agreement of the majority (two of the three reviewers). The cases that fail to fulfill the diagnostic criteria for work-relatedness are rejected and excluded from Internet-based reporting system, and these cases are not included in the study. The criteria for work-relatedness are decided upon and revised regularly by consensus of all specialists in occupational medicine in the NODIS. Each center is required to report at least the number of cases reported in the baseline year of 2006. The flowchart of the reporting process of this reporting system is presented in Fig. 3.

\textbf{Figure 3}

Flowchart of the reporting process of occupational diseases.

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\textbf{Figure 3}

Flowchart of the reporting process of occupational diseases.
Study objectives

The aims of this study are to describe the distribution of occupational diseases across occupations and industries from 2008 to 2010 in Taiwan and to consider the possible influence of the new NODIS system, comprised of CODISs and their local network hospitals, on compensable occupational diseases.

METHODS

To describe the distribution of occupational diseases across occupations and industries from 2008 to 2010 in Taiwan, this study used a secondary data analysis of the database of the Internet-based reporting system and the database of compensated occupational diseases from the public statistics data of the National Labor Insurance scheme. The variables collected from the Internet-based reporting system included gender, age, industry and occupation, diagnosed diseases or injuries, time of diagnosis, and the workplace exposure and hazards that caused the ailment. The variables from the National Labour Insurance database include gender, age, industry and occupation, diagnosed diseases or injuries, and time of diagnosis, but do not include workplace exposure and hazards. To measure the possible influence of the NODIS system, we compared Labor Insurance compensation data with the reporting system data from 2005 to 2010.

To calculate rates of occupational disease, we obtained the total employment figures for different industrial sectors and occupation categories in Taiwan from the statistical data published by the Council of Labor Affairs. The classification of industrial sectors was based on the International Standard Industrial Classification of All Economic Activities in 1958, and the classification of occupation categories was based on the International Standard Classification of Occupations in 1988.

Statistical analysis

The numbers and distribution of reported occupational diseases from the Internet-based reporting system are reported using descriptive analysis. The definition of time of occurrence of occupational disease was the time of disease diagnosis by physician. To compare the change before and after the establishment of the national network service system as well as the national reporting system, the time trend of the annual incidence rate of reported occupational diseases from 2005 to 2010 was analyzed. Occupational diseases were reported by specialists in occupational medicine at four centers in 2005, five in 2006, and seven in 2007. Beginning in 2007, all NODIS sites were using the Internet reporting system. In addition, the time trend of the annual incidence rate of compensable occupational diseases from National Labor Insurance data, including cases of disability or death, were analyzed during the same period and compared with the reported occupational diseases.

The workers with the most commonly reported occupational diseases were further classified into subgroups according to their industrial sectors and occupation categories. The incidence rates of occupational diseases for different industrial sectors and occupation categories were also calculated. The annual incidence rate of an occupational disease of interest was defined as the number of workers with the new disease of interest in a given year (2008, 2009, and 2010) divided by the annual average total employment for different industrial sectors and occupation categories in the same year. SAS 9.2 software was used to calculate all of the study data.
RESULTS

As CODISs were gradually established, the annual incidence rate of reported occupational diseases increased. The change is most clear in 2007; when the coordination center launched the new Internet-based reporting system. The annual incidence rate of reported occupational diseases underwent a 1·3-fold increase from 2007 to 2008. The incidence rate decreased in 2009 and returned to the level of 2008 in 2010. The annual incidence rate of occupational diseases compensated by the Bureau of National Labor Insurance scheme shows a similar increasing trend with a 2·0-fold increase from 2007 to 2010 (Fig. 4). In addition, among those occupational diseases compensated by the Labor Insurance scheme, approximately 24% (2008), 46% (2009), and 61% (2010) were reported by the NODIS.

Figure 4
Annual incidence rates of reported occupational disease from the national service network for occupational disease and injury services and compensable occupational diseases by the Bureau of National Labor Insurance, 2005–2010. X-axis is the time in year and Y-axis is the annual incidence rate (per 100 000).

During 2008–2010, a total of 3134 cases of occupational disease were reported and fulfilled the criteria for occupational disease. The female-to-male ratio was 0·69, and the mean age was 46·5 years with a standard deviation of 12·1 years. The 45–54 years age group suffered from occupational diseases most frequently, followed by 35–44-year olds (Table 1). The most frequently reported occupational diseases were carpal tunnel syndrome (CTS), lumbar disc disorder (LIDD), upper limb musculoskeletal disorders, and contact dermatitis during the period of 3 years (2008–2010). For CTS, both male and female 45–54-year-old workers had the highest number of cases, followed by 35–44-year olds. For LIDD, 45–54-year-old workers, both male and female, had the highest number of cases. The second highest number of cases occurred among 35–44-year-old males and among 55–64-year-old females. For contact dermatitis, the highest number of cases in both genders was reported among 25–34-year olds. For pneumoconiosis, the highest number of cases in both genders was among the workers aged over 65 years. For caisson disease, all cases were male, and the most frequent age group was the 35–44-year olds. For asthma, the highest number of cases occurred among 45–54-year-old males and 25–34-year-old females. For NIHL, the age group with the highest number of male workers was the 45–54-year olds. Male workers had more LIDD, pneumoconiosis, caisson disease, noise-induced hearing loss (NIHL), and cervical intervertebral disc disorder than females, but female workers had a high number of CTS (Table 2). Regarding the exposure factors, the most common factors were ergonomic (63·2%), chemical (22·9%), and physical (10·4%).

Demographics of workers with reported occupational diseases, 2008–2010

Table 1
Ten diagnoses (ICD-9 code) with the highest numbers of reported occupational diseases, with age and gender distribution, 2008–2010
For the two most commonly reported occupational diseases, namely CTS and LIDD, we further analyzed frequency distribution and annual incidence rates by various industrial sectors and occupational categories. The industries with the highest annual incidence rates of reported occupational CTS were mining and quarrying (2008), electricity and gas supply (2009), and arts, entertainment, and recreation (2010). The occupations with the highest annual incidence rates of reported occupational CTS were service, shop and market sales workers (2008), and production and machine operators (2009 and 2010) (Table 3). The workers in the following industries had the highest annual incidence rates of reported occupational LIDD: mining and quarrying (2008 and 2009) and transportation and storage (2010). The occupations with the highest annual incidence rates of reported occupational LIDD were production and machine operation from 2008 to 2010 (Table 4).

### DISCUSSION

The NODIS model in Taiwan is similar to the Union Health Center in New York City, which linked the occupational health clinic with preventive occupational health services and also increased the occupational medicine physicians’ expertise. The number of clinics providing occupational health services to workers with occupational diseases or injuries obviously increased after the establishment of this system. This approach may reduce the practice of underreporting occupational diseases and increase the coverage rate of occupational health services. In addition, the system has also led physicians or other health care providers to learn how to recognize occupational diseases. Thus, the greater ability of occupational health services and information may be the reason for the increase in reporting during 2008 to 2010.

The network system could compensate for the weakness of the combined health insurance scheme. Because medical services for the general population and workers with occupational diseases or injuries are currently available from the same national health insurance infrastructure in Taiwan, the medical cost may shift from the workers’ compensation...
system to the general health care system. For example, a case management approach for workers with occupational diseases or injuries had not been fully conducted before the system’s establishment. With the advent of NODIS, case managers are available to coordinate workers’ health care, assist in returning to work, and educate workers to reduce hazardous exposures. For another example, other medical specialists, special management teams, and other health care provider or experts (i.e., occupational therapist, physical therapist, clinical psychologists) working within medical centers where CODISs are located also provide medical services to workers with occupational diseases or injuries; this type of combined care may increase the quality of occupational health service provision. The Internet-based occupational reporting system has been able to provide valuable information on occupational diseases in an efficient manner.

The study results show that as the annual number of reported occupational diseases increased, the annual number of compensable occupational diseases also increased. The reason for the dramatic increase in the numbers of reported or compensable occupational diseases may be the establishment the reporting system or reflect a true increase in occupational hazards. Because a nationwide occupational hazard reporting or surveillance systems is not currently available in Taiwan, we cannot verify the actual reason for the increase. Some researchers have found that failure to integrate occupational medicine into primary care settings can result in the misdiagnosis of occupational diseases. Thus, the establishment of the NODIS to provide access to specialist evaluations of work-relatedness is likely the reason for the dramatic increase.

In this study, reported occupational diseases increased 3.9 folds from 2005 (287 cases) to 2010 (1117 cases). A drop in the number of reported occupational diseases was observed in 2009, most likely due to the economic crisis in the latter half of 2008, which resulted in significantly increased unemployment in many industrial sections. During such a crisis, the willingness of workers to seek medical attention for suspected occupational diseases may have been reduced. However, with the stabilization of the economy, the reported number of occupational diseases in 2010 returned to the level in 2008.

According to Taiwan’s National Labor Insurance, among compensated workers with occupational diseases, 61% were diagnosed by specialists in occupational medicine from the occupational health service network in 2010 (data not shown). Therefore, although the diagnosis of occupational disease may take place outside this network, the majority of occupational disease diagnoses were made by this network. Because the NODIS is supported by the Council of Labor Affairs, governmental subsidies may be the key to success in establishing occupational health services in medical institutions to workers sustaining occupational diseases or injuries under no comprehensive medical services from labor insurance scheme. Among the 3134 workers with occupational diseases, 45–54-year-old workers made up the largest age group, possibly because workers in this age group are more prone to such diseases, or are overrepresented in the industries that carry the risk of these diseases. For example, CTS is most common in workers aged 45–65 years. Male workers had more cases with occupational diseases than females, including among the top 10 occupational diseases, such as LIDD, pneumoconiosis, caisson disease, and NIHL. The high incidence rates of CTS (in 2008) and LIDD (in 2009 and 2009) in mining and quarrying workers could be explained by the small number of cases (≤3) and persons employed in the industry (less than six thousand). The diseases with highest incidence were those caused by ergonomic factors, including CTS, LIDD, and musculoskeletal diseases of the upper limbs. This finding is in agreement with reports from most developed countries. Lung diseases (mainly pneumoconiosis and occupational asthma), skin diseases, and NIHL were also frequently reported. These disease trends are also similar to the pattern of reported occupational diseases in developed countries. In 2010, approximately 60% of financially active people worked in service industries, and fewer than 40% worked in manufacturing, agriculture, etc. This pattern is similar to that in industrialized
countries. Regarding the 129 cases of caisson disease, 103 were reported from a local network hospital located near the ocean and likely to receive cases of this type.

In 2010, arts, entertainment, and recreation and construction were for the first time among the five industries with the highest annual incidence rates of reported occupational CTS. In addition, production and machine operation and service, shop, and market sales were the most common occupations with reported occupational CTS. These are jobs known to carry a risk for CTS. Workers in these industries should be educated about highly repetitively movements, inadequate posture, forceful movement, and vibration exposures on the hands and wrists to prevent occupational CTS.\textsuperscript{14,15} Although International Labour Organization and European Communities' lists of occupational diseases do not include intervertebral disc disorder, Taiwan’s list of occupational diseases has included the disease since 2008. The annual incidence rates of LIDD in the transportation and storage industries has increased from 5·56 per 100 000 workers (2008) to 10·89 per 100 000 workers (2010), and production and machine operators most frequently reported occupational LIDD. The workers performing these jobs should be warned of the risks of lifting, forceful movement, and whole body vibration for the prevention of occupational LIDD.\textsuperscript{16}

Despite the establishment of the Internet reporting system, underreporting may remain an issue in Taiwan and constitute a limitation of this study. Possible reasons for underreporting may include physician lack of training in recognizing occupational diseases, physician fear of legal hassles, workers not making a connection between their health and their job, and worker fears of producing conflict between employees and employers.\textsuperscript{3,17} Thus, multiple sources or systems to collect the data on occupational diseases and use of special epidemiologic methods, such as capture–recapture estimation, could be useful in reducing the severity of underreporting.\textsuperscript{18}

In conclusion, occupational health services for workers with occupational diseases or injuries in medical institutes have been recently organized into a national service network, which includes nine tertiary referral medical centers, 52 local network hospitals, and a coordination center. The subsidy from the labor authority, the Council of Labor Affairs, was an important support for the system. Effective reporting of occupational diseases provides important insight into the overall picture of these conditions in Taiwanese workers and allows for the development of preventive strategies for occupational health and safety. Taiwan’s experience in establishing the national service network and reporting systems may provide an example for newly industrialized countries from which to develop strategies for future occupational health services for workers with occupational diseases or injuries. Future work will involve regular assessments with evidence-based studies to validate the quality and efficacy of the occupational health services in the network service system, as well as the quality of data reported.

**DISCLOSURE STATEMENT**

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