HHS Public Access

Author manuscript

Semin Respir Crit Care Med. Author manuscript; available in PMC 2016 June 01.

Published in final edited form as:

Semin Respir Crit Care Med. 2015 June ; 36(3): 449–454. doi:10.1055/s-0035-1549456.

Surveillance for Occupational Respiratory Diseases in Developing Countries

Vinicius C. Antao, MD, MSc, PhD[1] and **Germania A. Pinheiro, MD, MSc, PhD**[1]

[1]Division of Toxicology and Human Health Sciences, Agency for Toxic Substances and Disease Registry (ATSDR), Centers for Disease Control and Prevention (CDC), Atlanta, Georgia

Abstract

The burden of chronic diseases, including occupational respiratory diseases (ORDs), is increasing worldwide. Nevertheless, epidemiological data on these conditions are scarce in most countries. Therefore, it is important to conduct surveillance to monitor ORDs, particularly in developing countries, where the working population is especially vulnerable and the health system infrastructure is usually weak. This article provides a general framework for the implementation of ORD surveillance in developing countries. The main objectives of surveillance are to describe incidence and prevalence of ORDs, as well as to identify sentinel events and new associations between occupational exposures and health outcomes. Diseases with high morbidity and mortality and those in which early diagnosis with standardized tests are available are especially suitable for surveillance activities. Simple strategies, preferably using existing resources and technology, are the best option for surveillance in developing countries. This article offers examples of specific surveillance systems that are in place in Brazil, China, Cuba, India, and South Africa.

Keywords

surveillance; occupational diseases; respiratory diseases; epidemiology; public health

Public health surveillance is the ongoing, systematic collection, analysis, and dissemination of health-relevant data. It can be used as an alert system for public health emergencies, to drive preventive measures, and to develop policies and practices to reduce morbidity and mortality, which may ultimately improve public health conditions. Surveillance systems can be implemented on several levels, ranging from local programs to global initiatives.[1]

The World Health Organization (WHO) has several global and regional surveillance systems, including the Global Foodborne Infections Network and the Integrated Disease Surveillance Program in Africa.[1] Similarly, the United States Centers for Disease Control and Prevention (CDC) uses the National Notifiable Diseases Surveillance System to monitor

Address for correspondence Vinicius C. Antao, MD, MSc, PhD, Division of Toxicology and Human Health Sciences, Agency for Toxic Substances and Disease Registry (ATSDR), Centers for Disease Control and Prevention (CDC), 4770 Buford Highway NE, MS F58, Atlanta, GA 30341 (VAntao@cdc.gov).

Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the official positions of the Centers for Disease Control and Prevention or the Agency for Toxic Substances and Disease Registry.

national health trends from 57 state, territorial, and local reporting jurisdictions.[2] In the United Kingdom, Public Health England maintains a real-time syndromic surveillance system for the early identification of potential human or veterinary public-health threats.[3] However, all of these initiatives are mostly focused on infectious diseases. Nevertheless, non communicable diseases (NCDs) are now the leading global causes of death. Except for Africa, chronic diseases, such as heart disease, stroke, cancer, chronic respiratory diseases, and diabetes, are the most frequent causes of death in the majority of countries. NCDs are projected to exceed communicable, maternal, perinatal, and nutritional diseases as the most common causes of death by 2030, even in low- and middle-income countries.[4] The burden of occupational diseases will likely follow this trend, especially in emerging economies, due to the close—and historical—links between industrialization and increased air pollution and other health hazards.

The worldwide incidence of pneumoconiosis and other occupational chronic respiratory diseases have been estimated at 453,000 and 2,631,000 cases per year, respectively.[5] Moreover, in the year 2000, occupational exposures were estimated to be associated with 12% of chronic obstructive pulmonary disease (COPD) deaths and 17% of asthma deaths worldwide.[6] In addition, occupational exposures to silica, asbestos, and coal mine dust may have caused 9,000 deaths from silicosis, 7,000 deaths from asbestosis, and 14,000 deaths from coal workers' pneumoconiosis worldwide in that year.[6] In the United Kingdom, 5.3% of all cancer deaths in 2005 have been attributed to occupational exposures. Of these, 12% were cancers of the larynx and lungs, or mesotheliomas, most of which were associated with exposure to asbestos.[7] Therefore, it is essential that effective surveillance systems be created to address the increasing burden of occupational respiratory diseases (ORDs), especially in developing countries, where data are frequently scarce.

The International Labor Organization (ILO) states in Article 11 of its Occupational Safety and Health Convention (C155), promulgated in 1981, that ratifying countries shall ensure "the establishment and application of procedures for the notification of occupational accidents and diseases, by employers and, when appropriate, insurance institutions and others directly concerned, and the production of annual statistics on occupational accidents and diseases."[8] In addition, the ILO Protocol of 2002 to the Occupational Safety and Health Convention describes the systems for recording and notification, and highlights the need for the annual publication of national statistics based on occupational accidents and occupational diseases notifications.[9] Since its entry into force in August 11, 1983, the convention C155 has been ratified by 63 countries, 39 of which are low- or middle-income economies; only 3 of these countries (Albania, El Salvador, and Syrian Arab Republic) have actually ratified the Protocol of 2002. Nevertheless, none of these three countries have statistics readily available on ORD or even other occupational diseases.

Objectives of Occupational Respiratory Disease Surveillance

One of the main purposes of ORD surveillance systems is to describe incidence and prevalence. In addition to providing a snapshot of new and existing cases in a given period, these data are useful for describing disease trends over time. These elements are extremely

important for establishing control and research priorities, as well as for evaluating possible interventions.[10]

Surveillance is also important to identify individual cases of ORDs, which may in turn be useful to find other cases in the same workplace. Sometimes referred to as sentinel events, these cases suggest potentially hazardous exposures, usually indicating that a broader public health investigation or intervention is required.[11]

Finally, ORD surveillance may uncover new associations between occupational agents and health outcomes. For example, bronchiolitis obliterans in microwave popcorn workers[12] and pulmonary alveolar proteinosis in indium processing workers[13] have been described in recent years.

Elements of a Surveillance Program

Before starting a surveillance program, several points should be considered, with regard to which diseases will be assessed and which tests will be used to detect them.[14]

First, the disease should be associated with significant morbidity or mortality. If medical screening is being used as the basis of the surveillance program, the disease should be identifiable at a stage where patients have not yet developed symptoms and therefore would not have sought medical attention; in addition, it should be responsive to existing treatments or to interventions that could avoid further progression among individuals or populations (i.e., primary or secondary prevention measures should be available).[14] Coal workers' pneumoconiosis (CWP) for instance, meets all of these requirements. It is associated with substantial loss of lung function in late stages, but is usually asymptomatic if early diagnosis is made (typically through an active surveillance program); furthermore, early identification of cases followed by removal from coal mine dust exposure is essential to reduce the probability of progressive massive fibrosis.[15] Nevertheless, these are not a requirement for surveillance per se, as population-based figures can be useful for public health purposes even where there is no effective, acceptable treatments. For example, mesothelioma surveillance can be useful, even though the disease remains incurable with no acceptable interventions.

If a specific test is being used for case identification in the surveillance program, it should have adequate sensitivity, specificity, and predictive value in the target population; be acceptable to subjects; be available at a reasonable cost; and be standardized enough as to be done with adequate reproducibility, consistency, and accuracy.[14] A good example is the International Classification of Radiographs of Pneumoconiosis, developed by the ILO, which is a standardized classification that facilitates comparisons of data on pneumoconiosis, epidemiological investigations, and research reports.[16]

As an alternative to creating a unique surveillance program, several existing data sources can be employed as surveillance tools. These include, but are not limited to, registries, government surveys, employer-based surveillance systems, workers' compensation reports, laboratory reports, physician reports, death certificates, hospital discharge data, and national

surveys.[10] Each of these sources has advantages and limitations, which should be taken into account, depending on the specific purpose of the surveillance program.

Nevertheless, every ORD surveillance program should have qualified occupational health professionals to manage the program, well-defined record-keeping protocols, validated quality assurance procedures, and strict confidentiality practices.[14] The American Thoracic Society's Methods in Epidemiology, Clinical and Operations Research (MECOR) program is an example of a program that has succeeded in training professionals in developing countries in the skills needed to manage surveillance programs.[17]

Surveillance for ORDs in High-Income Countries

Several surveillance systems for ORDs are in place in high-income countries. The most comprehensive ones rely on mandatory notification of occupational diseases. Others are based on national mortality data. Although these systems may not be appropriate for developing countries because of their complexity, the following examples may serve as general guidance for surveillance implementation.

- **Surveillance of work-related and occupational respiratory diseases (SWORD)**

  SWORD has been operational in the United Kingdom since 1988. It receives funding from the Health and Safety Executive, with support of the British Thoracic Society and the Society of Occupational Medicine. More than 400 physicians across the United Kingdom voluntarily report ORD cases to SWORD. New cases of occupational asthma, benign and malignant pleural diseases, mesothelioma, lung cancer, pneumoconiosis, and other ORDs are reported through an online system. Reporting takes place on a monthly basis by 20 "core" physicians and 1 month per year by noncore physicians. All the information reported is confidential.[18]

- **Finnish Registry of Occupational Diseases (FROD)**

  FROD is maintained by the Finnish Institute of Occupational Health (FIOH) in Helsinki and has been in place since 1964. Reporting by physicians is mandatory and the system also captures data reported to insurance companies. Cases are reviewed for multiple reports by FIOH and classified into the following categories: hearing loss, repetitive strain injury, allergic respiratory diseases, skin diseases, asbestos-related diseases, and other occupational diseases. Personal identifiers and employment information are also collected.[19]

- **Surveillance of Australian Workplace-Based Respiratory Events (SABRE)**

  SABRE was implemented in the Australian states of Victoria in 1997, Tasmania in 1998, and New South Wales in 2001. It is based on voluntary reports of physicians, who provide data on allergic alveolitis, asthma, bronchitis, inhalational injury, lung cancer, mesothelioma, pneumoconiosis, non malignant pleural diseases, infectious diseases, and other ORDs. Non identifiable data are collected and reported via the Internet. It has been suggested that SABRE be implemented in Australia on a national level.[20,21]

- **Coal Workers' Health Surveillance Program (CWHSP)**

The CWHSP is maintained by the US National Institute for Occupational Safety and Health (NIOSH). It was established by the Federal Mine Safety and Health Act in 1970 and originally included an X-ray surveillance component and the B-reader program, which tests and certifies readers in the ability to classify radiographs according to the ILO classification.

In light of evidence for geographic clustering of rapidly progressive cases of CWP[22] and the consequent publishing of the Mine Safety and Health Administration's new rule on respirable coal mine dust exposure,[23] the Program is being expanded and now includes spirometry surveillance and active surveillance with a mobile examination unit. Participation is voluntary (except for pre-employment tests). Radiographs are offered about every 5 years.[24]

- **National Occupational Respiratory Mortality System (NORMS)**

  NORMS is a query system maintained by NIOSH. It is based on national mortality data compiled by the National Center for Health Statistics (NCHS) since 1968. The conditions covered by NORMS are hypersensitivity pneumonitis, pneumoconioses, and malignant mesothelioma (since 1999). In addition, industry/occupation-specific mortality data are available for the period 1985–1999 for asthma, COPD, conditions due to chemical fumes and vapors, influenza, lung cancer, malignant neoplasm of the pleura, mycobacterial infections, other interstitial pulmonary diseases, pleural plaque (1999 only), pneumonia, and tuberculosis.[25]

- **NIOSH State-Based Surveillance Program**

  NIOSH funds cooperative agreements for State-Based Occupational Safety and Health Surveillance for which some states conduct population-based surveillance for pneumoconiosis (hospitalizations and mortality). Some states also perform case-based sentinel surveillance focused specifically on silicosis and/or work-related asthma (WRA). Direct report from physicians is the main source of information in this system.[26]

  Despite the utility of these surveillance systems, high-income countries are also subject to many problems in terms of gathering information on ORD, such as the lack of nationally representative data and various degrees of underreporting. An evaluation of six national occupational disease registries in European Union countries (Austria, Belgium, the Czech Republic, France, Finland, and the United Kingdom) showed that their quality was only "limited," with criteria for notification and participation of notifying physicians being the major deficiencies on most registries, leading to the conclusion that they do not adequately monitor existing occupational diseases or adequately alert to newly occurring occupational diseases.[27]

Surveillance for ORDs in Low- and Middle-Income Countries

The need for occupational disease surveillance in low- and middle-income countries can be easily justified by several factors. Growing rates of industrialization pose increasing risks of exposure to hazardous substances in those countries. In addition, in a globalized economy, it

is not uncommon that rich nations will transfer dangerous industrial processes to developing countries, where manpower is cheaper and legislation and enforcement are usually less rigorous. A recent example is the epidemic of silicosis among denim sandblasters in Turkey.[28,29] Finally, the workforce in developing countries is generally less aware of workplace safety and health practices, child labor is more common, and the overall health status of the population is lower, when compared with developed nations. All of these elements make workers in developing countries especially susceptible to occupational health hazards.[30]

The implementation of surveillance systems may be particularly challenging in low- and middle-income countries, not only because of the uniqueness of certain environments but also due to their common infrastructural problems. These include insufficient health services and deficient reporting systems, lack of trained occupational health professionals, inadequate or nonexistent health legislation and basic services, as well as weak industrial infrastructure and controls.[30]

Usually the best approach to establish surveillance systems in developing countries is to employ simple strategies, preferably using existing resources and technology. For example, ORD surveillance could be integrated with primary health care services, after appropriate training of the personnel who would be involved in the diagnosis of ORDs (e.g., reporting of pneumoconiosis integrated with tuberculosis notification, in settings where both diseases have high prevalence). The inclusion of occupational diseases among national notifiable conditions is another strategy. In that case, compulsory notification usually produces better results if accompanied by proper education of health professionals and simple notification schemes. The use of hospitalization data could also be implemented, with the caveat that only more serious cases would be captured. This option may be better suited to occupational injuries and acute exposure to toxic substances. Mortality data can also be used as a source of ORD surveillance, but it is often subject to under recognition, underreporting, and coding problems. Finally, another possibility is to focus surveillance activities on exposures rather than diseases (e.g., registries of industries, including work processes and materials), which could be useful as a primary prevention tool.[30]

The following examples illustrate the experience of selected developing countries with ORD surveillance activities in Latin America, Asia, and Africa.

- **Brazil**

  The Brazilian Ministry of Health started the implementation of an integrated system for compulsory notification of diseases in 1993. It became nationally comprehensive in 1998, but originally included only infectious diseases. In 2004, occupational injuries and some occupational diseases were added to the list, including pneumoconiosis and occupational cancers.[31] Nevertheless, the system appears to be underutilized and subject to substantial underreporting in the field of occupational health. According to preliminary reports, a total of 58,878 cases of occupational injuries and diseases were recorded in 2007. In contrast, 653,090 of those cases were listed by the Brazilian Social Security Administration in the same

period.[31] Moreover, data on ORDs from the national notification system are not publicly available.

Another possible source of ORD data in Brazil is the National Mortality System. In the State of Rio de Janeiro, Pinheiro et al demonstrated that mesothelioma mortality data were subject to codification problems, underreporting, and misdiagnosis.[32] Pedra et al described 2,414 mesothelioma deaths in the period 1996 to 2003 in Brazil, using a combination of International Classification of Diseases 9 (ICD-9) codes 163 (malignant neoplasm of pleura) for 1980–1995 and ICD-I0 codes C45 (mesothelioma) and C38.4 (malignant neoplasm of pleura) for 1996–2003.[33]

- **China**

  A law with the purpose of preventing, controlling, and eliminating occupational disease hazards went into effect in China, in May 1, 2002.[34] It details all provisions for prevention and control, diagnosis, supervision and inspection, and legal responsibilities regarding occupational diseases. In 2006, the country introduced a national network of occupational disease reporting. The system allows for online direct reporting to the Institute of Occupational Health and Poisoning Control. It is characterized by standardized reporting indicators (data are more readily available and comparable), real-time data about the number of cases of pneumoconiosis and prevalence trends, and dynamic observation and follow-up reports of the cases.[35]

  Occupational disease reporting is an important part of China's public health information system because the country faces a very high incidence of occupational diseases. For example, the number of workers exposed to silica-containing dusts was estimated to be as high as 12 million.[36] The incidence of pneumoconiosis was estimated at 12,000 to 15,000 cases annually, which represents 70 to 80% of the total number of cases of reported occupational diseases. A total of 638,234 cases of pneumoconiosis have been recorded in China between 1949 and 2008. Most of the cases were found in coal mining, followed by construction, materials, and manufacturing, metallurgical, nonferrous metal, and machinery industries.[36]

- **Cuba**

  The Cuban National Institute for Occupational Health (Instituto Nacional de Salud de los Trabajadores [INSAT]) runs a national epidemiologic surveillance system for occupational diseases.[37] The system has two components: tactical and strategic. The tactical component is dedicated to acute events, such as exposures to toxic substances, industrial accidents, outbreaks, and infectious diseases in the workplace. The strategic component focuses on five subsystems: work fitness and disability evaluations, occupational diseases, occupational injuries, workplace risks, and occupational mortality. In the case of occupational diseases, annual incidence data are collected nationally, processed through the National Bureau of Statistics, and distributed to other national agencies involved in occupational health surveillance.[38]

  A retrospective study found 28 cases of ORDs among 96 occupational disease cases diagnosed at INSAT in the period 1988 to 2006. Occupational asthma was

the most common diagnosis (12 cases, 42.8%), followed by pneumoconioses (9 cases, 32.1%), hypersensitivity pneumonitis (5 cases, 17.8%), and occupational bronchitis (2 cases, 7.1%). Interestingly, use of personal protective equipment (PPE) was captured in 22 cases, but only six patients (27%) had used PPE.[39]

- **India**

  Despite extensive legislation, including the Mines Act, which was promulgated in 1952, including silicosis and CWP, and later asbestos-related diseases (included in 1986), and other sector-specific legislation, the situation of ORD surveillance in India remains deficient. Moreover, more than 90% of the Indian workforce does not work in factories and therefore are not protected by specific legislation.[40]

  It is estimated that 1million people are employed in the mineral sector in India, with more than one-third in coal mining.[41] There are over 3 million workers exposed to silica dust, and 8.5 million more work in construction and building activities, similarly exposed to quartz.[42] In addition, India imports nearly 100,000 metric tons of asbestos per year, which poses another important health risk to the workforce.[43] In contrast, only 111 cases of CWP and 123 cases of silicosis have been reported to the Director General, Mines Safety in the period 1994 to 2011, according to a report submitted to the ILO.[41] Nevertheless, the document proposes a series of measures to establish effective surveillance and to control occupational diseases in India over the period 2012 to 2017.

- **South Africa**

  Currently, there are two main sources of ORD data on a national basis in South Africa: an autopsy program for deceased miners and a database of miners with ORD diagnosed by occupational health services and maintained by the Department of Mineral Resources.

  The South Africa Occupational Diseases in Mines and Works Act (1973) requires that the cardiorespiratory organs of a deceased miner be examined for the presence of occupational disease, regardless of the clinical cause of death and provided that next-of-kin authorization is obtained. These examinations are performed by pathologists at the National Institute for Occupational Health (NIOH). A detailed report on each case examined is sent to the Medical Bureau for Occupational Diseases (MBOD). Cases certified as having a compensable disease are then referred to the Compensation Commissioner's Office, where the payment for compensation is managed. Since 1975, the pathological findings from the autopsy examinations have been recorded on the PATHAUT database. This system comprises data from autopsy examinations and clinical files, which include occupational histories. The database is unique and provides an important resource for both surveillance and research. These data are the only comprehensive surveillance data on ORD in the South African mining industry. In the period 1975 to 2013, a total of 109,076 autopsies have been performed under this program. According to the 2013 PATHAUT report, the distribution of cases was as follows:

emphysema, 422 cases; pulmonary tuberculosis, 228 cases; silicosis, 276 cases; asbestosis, 71 cases; mesothelioma, 39 cases; and lung cancer, 39 cases.[44]

According to the Mine Health and Safety Act of 1996, every occupational medical practitioner at a mine must compile an annual medical report. These standardized forms are used to report different medical conditions (pulmonary tuberculosis, silicotuberculosis, asbestosis, pneumoconiosis, noise-induced hearing loss, silicosis, and other diseases). The latest available national report describes that in 2007, there were 4,588 cases of tuberculosis; 1,681 cases of silicosis; 526 cases of silicotuberculosis; 60 cases of CWP; and 46 cases of asbestos-related diseases in South Africa.[45]

Conclusion

Surveillance for ORDs is extremely important in developed and developing countries alike. By providing objective measures of disease incidence, prevalence, or mortality, as well as allowing for the identification of sentinel events, surveillance stands as the basis for the development of public health policies and interventions to reduce the burden of ORDs worldwide. Nevertheless, ORD surveillance data remains scarce in most countries. The need for raising the priority of preventing chronic diseases, including ORDs, has long been identified. It is paramount that ORD surveillance systems be implemented to carry out this task.

Acknowledgments

The authors would like to thank Kathleen Kreiss, MD, and Gregory R. Wagner, MD, for their contributions to this article.

References

1. World Health Organization. [Last accessed September, 15 2014] Public health surveillance. Available at: http://www.who.int/topics/public_health_surveillance/en/.
2. Centers for Disease Control and Prevention. [Last accessed September 15, 2014] National Notifiable Diseases Surveillance System (NNDSS). Available at: http://wwwn.cdc.gov/nndss/.
3. Public Health England. [Last accessed September 15, 2014] Syndromic surveillance: systems and analyses. Available at: http://www.gov.uk/government/collections/syndromic-surveillance-systems-and-analyses.
4. World Health Organization. [Last accessed September 15, 2014] Global status report on noncommunicable diseases 2010. Available at: http://whqlibdoc.who.int/publications/2011/9789240686458_eng.pdf.
5. Leigh J, Macaskill P, Kuosma E, Mandryk J. Global burden of disease and injury due to occupational factors. Epidemiology. 1999; 10(5):626–631. [PubMed: 10468442]
6. Driscoll T, Nelson DI, Steenland K, et al. The global burden of non-malignant respiratory disease due to occupational airborne exposures. Am J Ind Med. 2005; 48(6):432–445. [PubMed: 16299701]
7. Rushton L, Hutchings SJ, Fortunato L, et al. Occupational cancer burden in Great Britain. Br J Cancer. 2012; 107(Suppl 1):S3–S7. [PubMed: 22710676]
8. International Labour Organization (ILO). Occupational Safety and Health Convention, 1981 (No. 155). Available at: http://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0:NO:12100:P12100_INSTRUMENT_ID:312300:NO.

9. International Labour Organization (ILO). Protocol of 2002 of the Occupational Safety and Health Convention, 1981(P155). Available at: http://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0:NO:12100:P12100_INSTRUMENT_ID:312338:NO.
10. Markowitz, SB. Occupational disease surveillance and reporting systems. In: Stellman, JM., editor. ILO Encyclopedia of Occupational Safety and Health. 4th ed.. Geneva: International Labour Office; 1998. p. 32.2-32.7.
11. Buehler, JW. Surveillance. In: Rothman, KJ.; Greenland, S.; Lash, TL., editors. Modern Epidemiology. 3rd ed.. Philadelphia, PA: Lippincott Williams & Wilkins; 2008. p. 459-480.
12. Kreiss K, Gomaa A, Kullman G, Fedan K, Simoes EJ, Enright PL. Clinical bronchiolitis obliterans in workers at a microwave-popcorn plant. N Engl J Med. 2002; 347(5):330–338. [PubMed: 12151470]
13. Cummings KJ, Donat WE, Ettensohn DB, Roggli VL, Ingram P, Kreiss K. Pulmonary alveolar proteinosis in workers at an indium processing facility. Am J Respir Crit Care Med. 2010; 181(5): 458–464. [PubMed: 20019344]
14. Wagner, GR. Screening and Surveillance of Workers Exposed to Mineral Dusts. Geneva: World Health Organization; 1996.
15. Petsonk EL, Rose C, Cohen R. Coal mine dust lung disease. New lessons from old exposure. Am J Respir Crit Care Med. 2013; 187(11):1178–1185. [PubMed: 23590267]
16. Antao, VC.; Parker, JE. ILO classification. In: Gevenois, P.; De Vuyst, P., editors. Imaging of Occupational and Environmental Disorders of the Chest. Berlin: Springer; 2006. p. 93-99.
17. Buist AS, Parry V. The American Thoracic Society methods in epidemiologic, clinical, and operations research program. A research capacity-building program in low- and middle-income countries. Ann Am Thorac Soc. 2013; 10(4):281–289. [PubMed: 23952845]
18. Center for Occupational and Environmental Health. Surveillance of Work-Related and Occupational Respiratory Disease (SWORD). Available at: http://www.population-health.manchester.ac.uk/epidemiology/COEH/research/thor/schemes/sword/.
19. European Agency for Safety and Health at Work. Occupational Safety and Health Monitoring Systems. Finnish Register of Occupational Diseases. Available at: http://osha.europa.eu/en/topics/osm/reports/finnish_system_009.stm.
20. Elder D, Abramson M, Fish D, Johnson A, McKenzie D, Sim M. Surveillance of Australian workplace Based Respiratory Events (SABRE): notifications for the first 3.5 years and validation of occupational asthma cases. Occup Med (Lond). 2004; 54(6):395–399. [PubMed: 15347777]
21. Hannaford-Turner K, Elder D, Sim MR, Abramson MJ, Johnson AR, Yates DH. Surveillance of Australian workplace Based Respiratory Events (SABRE) in New SouthWales. Occup Med (Lond). 2010; 60(5):376–382. [PubMed: 20308261]
22. Antao VC, Petsonk EL, Sokolow LZ, et al. Rapidly progressive coal workers' pneumoconiosis in the United States: geographic clustering and other factors. Occup Environ Med. 2005; 62(10):670–674. [PubMed: 16169911]
23. Department of Labor. Lowering Miners' Exposure to Respirable Coal Mine Dust, Including Continuous Personal Dust Monitors; Mine Safety and Health Administration. 79 FR 84, 2014. Available at: http://www.gpo.gov/fdsys/pkg/FR-2014-05-01/pdf/2014-09084.pdf. [Last accessed September 15, 2014]
24. National Institute for Occupational Safety and Health. [Last accessed September 15, 2014] Occupational Respiratory Disease Surveillance. Coal Workers' Health Surveillance Program. Available at: http://www.cdc.gov/niosh/topics/surveillance/ords/cwhsp.html.
25. National Institute for Occupational Safety and Health. [Last accessed September 15, 2014] Occupational Respiratory Disease Surveillance. National Occupational Respiratory Mortality System (NORMS). Available at: http://webappa.cdc.gov/ords/norms.html.
26. National Institute for Occupational Safety and Health. [Last accessed September 15, 2014] Occupational Respiratory Disease Surveillance. State-Based Surveillance. Available at: http://www.cdc.gov/niosh/topics/surveillance/ords/StateBasedSurveillance.html.
27. Spreeuwers D, de Boer AG, Verbeek JH, van Dijk FJ. Evaluation of occupational disease surveillance in six EU countries. Occup Med (Lond). 2010; 60(7):509–516. [PubMed: 20871020]

28. Akgun M, Mirici A, Ucar EY, Kantarci M, Araz O, Gorguner M. Silicosis in Turkish denim sandblasters. Occup Med (Lond). 2006; 56(8):554–558. [PubMed: 17021274]
29. Akgun M, Araz O, Akkurt I, et al. An epidemic of silicosis among former denim sandblasters. Eur Respir J. 2008; 32(5):1295–1303. [PubMed: 18579544]
30. Koh, D.; Chia, K-S. Surveillance in developing countries. In: Stellman, JM., editor. ILO Encyclopedia of Occupational Safety and Health. 4th ed.. Geneva: International Labour Office; 1998. p. 32.9-32.13.
31. Santana, VS.; Silva, JM. Os 20 anos da saúde do trabalhador no Sistema Único de Saúde no Brasil: limites, avanços e desafios. In: Brasil.Ministério da Saúde. , editor. Saúde Brasil 2008: 20 anos de Sistema Único de Saúde (SUS) no Brasil (Health Brazil 2008: 20 years of Unified Health System (SUS) in Brazil). Brasilia: Ministério da Saúde; 2009. p. 177-204.
32. Pinheiro GA, Antão VC, Monteiro MM, Capelozzi VL, Terra-Filho M. Mortality from pleural mesothelioma in Rio de Janeiro, Brazil, 1979–2000: estimation from death certificates, hospital records, and histopathologic assessments. Int J Occup Environ Health. 2003; 9(2):147–152. [PubMed: 12848243]
33. Pedra F, Tambellini AT, Pereira BdeB, da Costa AC, de Castro HA. Mesothelioma mortality in Brazil, 1980–2003. Int J Occup Environ Health. 2008; 14(3):170–175. [PubMed: 18686716]
34. [Last accessed September 15, 2014] National People's Congress. Law of the People's Republic of China on Prevention and Control of Occupational Diseases. Available at: http://www.china.org.cn/english/government/207413.htm.
35. Zhang X, Wang Z, Li T. The current status of occupational health in China. Environ Health Prev Med. 2010; 15(5):263–270. [PubMed: 21432554]
36. Liang Y, Xiang Q. Occupational health services in PR China. Toxicology. 2004; 198(1–3):45–54. [PubMed: 15138029]
37. Columbié EL, de la Vega EJ. El Instituto Nacional de Salud de los Trabajadores de la República de Cuba: un reto de país en desarrollo. Rev Cuba Hig Epidemiol. 1999; 37:161–168.
38. de la Vega EJ, Salso AG, Fernadez TM. Vigilancia epidemiológica e indicadores de salud y seguridad en el trabajo en Cuba. Rev Cuba Hig Epidemiol. 2001; 39:52–60.
39. Herrera SK, Manso JE. Caracterización clínico epidemiológica de las enfermedades broncopulmonares ocupacionales diagnosticadas en el Instituto de Salud de los Trabajadores, 1988–2006. Rev Cub Salud Trab. 2007; 8:46–51.
40. Tripathy JP. Occupational health hazard in India: need for surveillance and research. Curr Sci. 2014; 106:668–669.
41. Government of India. [Last accessed September 15, 2014] Ministry of Labour and Employment. Report of the Working Group on Occupational Safety and Health for the Twelfth Five Year Plan (2012 to 2017). Available at: http://www.ilo.org/wcmsp5/groups/public/—ed_protect/—protrav/—safework/documents/policy/wcms_211795.pdf.
42. Jindal SK. Silicosis in India: past and present. Curr Opin Pulm Med. 2013; 19(2):163–168. [PubMed: 23254775]
43. Dave SK, Beckett WS. Occupational asbestos exposure and predictable asbestos-related diseases in India. Am J Ind Med. 2005; 48(2):137–143. [PubMed: 16032742]
44. National Institute for Occupational Health. Pathology Division Surveillance Report. Demographic Data and Disease Rates for January to December 2013. Available at: http://www.nioh.ac.za/assets/files/Pathaut%20Report%202013.pdf.
45. Mine Health and Safety Inspectorate. [Last accessed September 15, 2014] Annual Report 2007/08. Available at: http://www.dmr.gov.za/mhsi-annual-reports/summary/128-annual-reports/883-mhsi-annual-report-2007-2008.html.