Proficiency, Procedures, and "B" Readers-Classifications of Radiographs for Pneumoconiosis[1]

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For nearly one hundred years, chest roentgenography has been an important tool for the recognition, investigation, and evaluation of occupational lung disease. As the technique became more formalized, it became apparent that readers often disagreed on the presence, type, and extent of lung disease observed among dust-exposed workers (1). These observations prompted efforts to refine the radiographic film-reading process. A standardized scoring procedure was developed to document the various types and degrees of dust-induced abnormalities; this became the International Labour Office (ILO) classification (2). A process began of selecting radiographs as standard comparison films representative of certain abnormalities (3). Investigators identified factors that affected the reliability of readings, such as image quality (4), and recommended procedures to reduce variation in readings (5).

With progressive improvement in techniques and procedures over the decades subsequent to its introduction, the ILO classification system emerged as a remarkably robust mechanism for assessing occupational disease. Classifications of radiographs show clear correlations with dust exposure, lung dust burden, lung pathology, and mortality (6–8). However, the full power of the ILO system is only realized with appropriate procedures. For example, in the Coal Workers' X-ray Surveillance Program, administered by the National Institute for Occupational Safety and Health (NIOSH), there are strict requirements for the x-ray film, exposures, and equipment to be used. Additionally, before films may be submitted under the Program, sample images from each radiography unit must be evaluated and approved by NIOSH. To reduce the effect of between-reader variation, all final pneumoconiosis determinations for the Program are based on agreement of 2 or more readers, using a specified algorithm. Furthermore, to assure that physician readers are trained and proficient in the classification of dust-related changes in chest roentgenograms, a system of professional certification, the NIOSH B reader program, was established (9,10).

The B-reader program has played a major role in advancing knowledge of radiograph classification in the United States. The program is intended to assist physicians interested in increasing their knowledge of the pneumoconiosis and related diseases, and in demonstrating their proficiency in reading radiographs using the ILO system. The program provides each candidate an opportunity to review the NIOSH self-study syllabus, and in partnership with the American College of Radiology, periodically offers comprehensive symposia on the radiology of the pneumoconioses (11). The B-reader certification examination is a rigorous evaluation of the physician's capability, at a single point in time, to identify and appropriately categorize radiographic changes of dust-related lung disease. It requires accurate categorization of a set of 125 test films within a period of 6 hours; historically, only about 50% of candidates are successful in passing the examination. There is a similar periodic recertification process. NIOSH has demonstrated ongoing interest in improving and updating the B-reader program to accommodate new developments, such as the advent of computed radiography, through stakeholder workshops, including those held in 1990 (12) and March of 2004. Analogous to a specialty board certification, the B-reader program is one of the central components of a comprehensive approach to assuring quality in obtaining and evaluating chest-radiographic images among dust-exposed

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workers. However, it does not provide for an ongoing assessment of a reader's performance during the normal course of professional or scientific activities. In contrast, the regulation and enforcement of the competent and ethical practice of medicine is the province of state medical licensing boards.

Classification of chest radiographs remains an important tool for medical surveillance, research, hazard evaluations, compensation programs, and medico-legal activities, and can also be useful in clinical assessments. In all applications, accuracy, precision, utility, and practicality are important. Consideration must be given to image quality, reader competence, inter-reader variability, acceptability, cost, and timeliness. However, the appropriate balance among these factors can differ, depending on the purpose of a radiograph. Classifications done for epidemiologic studies have a particular requirement for precision, to facilitate delineation of exposure–response relationships and recognition of modifying factors. It is now well established that such research must involve panels of trained and experienced readers, who are selected to be representative of general reading practices (ie, do not fall at either extreme of the range of variability between readers), who are informed about and assessed for intra- and inter-reader variability, and who read epidemiologic classification films under conditions of blinding to medical or exposure information or other readers' interpretations. A useful summary of criteria to consider when reading for epidemiologic purposes is given by Mulloy et al (13).

Classifications done for medical surveillance, which deals with monitoring groups of individuals at risk for disease, must weigh the costs of failing to detect disease or recognize hazardous conditions against the economic and social costs of falsely identifying disease. An appropriate balance must be maintained to assure a sensitive and practical surveillance program, with sufficient procedures to assure quality and accuracy. Surveillance programs generally involve ongoing screening of large numbers of apparently healthy individuals, and may be impractical if, because of inappropriate design, the costs of the procedures and follow-up are excessive.

Classifications of radiographs are also done for medico-legal purposes. The ILO, recognizing that classifications would be used for these purposes, cautioned that a classification by itself "does not imply legal definitions of pneumoconiosis for compensation purposes," and that findings consistent with pneumoconiosis can occur from other causes (14). Conversely, clinically important interstitial lung disease may be present among workers whose films are classified as negative (15,16). Thus, when assessing the role of dust exposure in the impairment observed in an individual worker, it is important to consider both the source and the results of all available findings. Using a single unblinded radiographic classification can result in decisions that may appear capricious to both claimants and defendants, owing to the intrinsic variability of the reading process. However, requiring complex and extensive documentation and procedures may be both costly and inequitable.

It has been said that "there is no gold standard for B-reading in surveillance settings" (17). This statement should be generalized: there is no gold standard for classifying radiographs for pneumoconiosis in any setting. Despite the best efforts in training, variation even among certified B readers has persisted and exists for pleural abnormalities (17), for asbestosis (18), and for coal workers' pneumoconiosis (19). In Britain, a careful and intensive program of inter- and intra-reader checks was maintained for many years by the National Coal Board, involving repeated reading and re-reading of special batches of films (20). Nevertheless, consistent differences remained among highly experienced readers (21), suggesting that even extensive procedures can only reduce, and not totally eliminate, inter-reader differences.

Over the past 30 years, many have recognized the phenomenon of inter-reader variation as an important issue; recommendations have been made repeatedly for procedures to address it (22–25). Recently, the issue was raised again by this journal in connection with litigation for compensation (26) (although the experimental design and conclusions of the article cited have been criticized in letters to the journal). In medico-legal situations, improper reading procedures for chest roentgenograms can create the potential for partiality to be manifested in either direction. In this and all applications, appropriate reading methods are critical to avoid extremes of under- or over-reading, and careful consideration should be given to issues of reader selection and calibration, and the use of multiple readers. Overall, readers and users of ILO classifications need to be more knowledgeable about the inherent limitations of classifications of pneumoconiosis, and be familiar with approaches to maximize their utility. NIOSH is currently developing materials for dissemination on its website that are intended to improve understanding of the strengths and limitations of chest-radiograph classifications, as well as to publicize recommended practices for the various applications.

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