

Field Study

## Effect of a Two-hour Training on Physicians' Skill in Interpreting Pneumoconiotic Chest Radiographs

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**Abstract:** Effect of a Two-hour Training on Physicians' Skill in Interpreting Pneumoconiotic Chest Radiographs: Nlandu Roger NGATU, *et al.* Department of Environmental Medicine, Kochi Medical School, Kochi University—**Objective:** Occupational lung diseases have specific radiographic manifestations not always well known by physicians. In Japan, asbestos-related diseases became a public health concern after the “Kubota Shock”, when a number of workers and residents living nearby a manufacturer of asbestos-made ducts developed mesothelioma caused by asbestos exposure. This preliminary intervention trial evaluated the effect of two-hour training on inexperienced physicians' skill in interpreting pneumoconiotic chest radiographs. **Methods:** One hundred-two Japanese physicians participated in two reading-tests, using 12 radiographs, before and after the two-hour training with ILO/ICRP and Japan Pneumoconioses Study Group (JPSG) reading materials. Physicians had to check for the presence or absence of *small opacity* and *pleural plaque* consistent with pneumoconiosis. Sensitivity and specificity equal or greater than 70% were considered good, 50 to 69% acceptable and less than 50%, poor. **Results:** Post-training improvements in physicians' skills were seen. For *small opacity*, there was an increase in the proportion of physicians with good specificity, from 42% to 60%. For *pleural plaque*, the proportion of physicians with good specificity and good sensitivity increased, from 60% to 67% and from 18% to 25%, respectively. Also, significant improvements were observed in overall sensitivity for *pleural plaque*, from 46% to 60% ( $p < 0.0001$ ), and specificity for *small*

*opacity*, from 65% to 73% ( $p < 0.0001$ ). **Conclusions:** This study showed that two-hour participatory training may enhance physicians' skill in interpreting pneumoconiotic chest radiographs. There are countries without any pneumoconiosis screening program despite the WHO/ILO call for worldwide cooperation in eliminating it. Although the two-hour course cannot replace the five-day ILO workshop, such a program would be useful in areas with environmental or occupational exposure to dust. (J Occup Health 2010; 52: 294–301)

**Key words:** Chest radiograph, ILO international classification, Physician, Pleural plaque, Pneumoconiosis, Small opacity

Pneumoconioses have relatively specific radiographic features such as diffuse lung parenchymal lesions that are not well known to most physicians. They comprise asbestosis, silicosis and other occupational lung diseases caused by exposure to dusts.

In Japan, asbestos-related diseases became a public health concern after the “Kubota Shock”, when a number of workers and local residents living near a water supply duct manufacturer developed mesothelioma, a malignancy caused by asbestos exposure. Since that time physicians' need to understand asbestos-related diseases have become greater than ever.

The WHO/ILO Global Program for the Elimination of Silicosis (GPES) was adopted in 2003, with the aim of establishing wide international co-operation in the global elimination of silicosis as an occupational health problem by the year 2030<sup>1)</sup>. Accordingly, related programs are being carried out in several countries aiming at the elimination of asbestosis.

Although the main source of exposure to asbestos is workplaces such as shipyards and asbestos textile or cement manufacturers, construction workers, electricians, etc. have potential exposures and environmental sources

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of asbestos also play a role. Disease clusters of mesothelioma related to environmental exposure to asbestos have also been reported<sup>2-4</sup>. They include residences near asbestos or vermiculite mines and prolonged exposure in buildings with open sources of contamination<sup>5</sup>.

Radiological imaging plays an important role in the diagnosis of silicosis and asbestosis. Although it has some limitations in terms of detecting the earliest findings of pleural and parenchymal lung abnormalities<sup>6</sup>, chest radiographs remain the most important method of chest imaging, providing an easily accessible, cheap and effective diagnostic tool<sup>7, 8</sup> which is the basic tool for identifying occupational and environmental lung diseases<sup>9</sup>. On radiographs, anatomical parenchymal structures are seen as overlapping, which affects the sensitivity and specificity of the method; it is sometimes difficult, especially for inexperienced physicians, to distinguish pleural plaque on plain chest radiograph from mimicking shadows, such as rib-companion shadows, serratus anterior and oblique externus abdominis muscles and extra-pleural fat.

The superposition of these structures sometimes poses a challenge in the interpretation of chest radiographs<sup>10, 11</sup>. Also, normal cross-section or tangential views of blood vessels can be misinterpreted as small opacities indicating interstitial lung disease<sup>12</sup>. Such misinterpretation may lead to misclassification of conditions consistent with pneumoconiosis. Therefore, improving physicians' skills in reading radiographs of pneumoconiosis would make it possible to diagnose more cases among people with occupational or environmental dust exposure history.

In order to provide effective training for reading radiographs of pneumoconioses, we aimed to evaluate the effect of a two-hour training using ILO standard films, especially selected for training in radiographs, and test radiographs to examine reading the proficiency of physicians in interpreting radiographs of pneumoconiosis.

## Subjects and Methods

### Subjects

In total, 105 Japanese physicians voluntarily took part in the program for occupational physician's continuous education in Kochi and Ehime prefectures, Japan. The first group consisted of 27 physicians from Kochi prefecture, Japan, who took part in the first two-hour training on the ILO 2000 International Classification of Radiographs of Pneumoconiosis (ILO/ICRP), co-organized by the Kochi Branch of the Japan Medical Association and the Department of Environmental Medicine, Kochi Medical School in March 2008.

Prior to the training, written invitations were sent to members of the association in which the scheduled training on pneumoconiosis was communicated. There were 27 respondents who participated in the training, but

two did not fully fill in reading sheets and were excluded from the analysis.

The second group of physicians consisted of 78 physicians from all over Japan, predominantly the west part of the country, who registered to attend the national annual conference of occupational safety and health in Ehime prefecture, Japan. Several weeks earlier, participants to this conference received the program in which the two-hour training on the ILO International Classification of Radiographs of Pneumoconioses (ILO/ICRP) was scheduled. Of hundreds of healthcare workers who took part in this conference, 78 physicians responded and attended the training session.

Among this group of participants, one physician didn't fully fill in the reading sheet and was excluded from the analysis. Therefore, the study sample comprised 102 physicians. All of them were Japan Medical Association Certified Occupational Physicians (JMACOP) who submitted written informed consent to participation in the study. Both groups were delivered the same lecture by the same lecturer, a certified US NIOSH B reader<sup>13</sup>, in the two-hour time frame.

According to the Japanese occupational health system, JMACOP members have to sit a given number of lectures on different themes related to occupational safety and health to maintain their certification though physicians are not obliged to attend all scheduled lectures.

### CXR films

Three sets of radiographs were used, namely ILO/ICRP<sup>14</sup> standard radiographs, patients' films used in the participatory training and the test films. The ILO standard radiographs were used to compare and classify dust-exposed workers' chest radiographs. In this training session, ILO standard films were also used for describing pneumoconiotic lung abnormalities (characteristics and profusion of small opacities, large opacities, and pleural plaques) during the participatory training. Participants were asked to use the ILO standard side by side with the subject films while they were classifying profusions of small opacities. However, classifying radiographs according to the profusion of small opacities was not the purpose of the tests.

The subject films used in the participatory training called Japan Pneumoconioses Study Group (JPSG) films<sup>15</sup>, were 31 basic films selected from about more than 300 archives from a cohort of an ongoing study at three Japanese hospitals: University of Fukui hospital, Rosai Silicosis Hospital and NHO Kinki Chuo Chest Disease Center. The films show all categories of small rounded opacities, irregular opacities, and give examples of pleural abnormalities, large opacities, lung cancers and mesothelioma.

The test films were twelve 34 × 34 cm chest radiographs of patients who had a history of dust

**Table 1.** Demographic characteristics of the study subjects

Readers' characteristics	Site A	SiteB	Total	%
1. Gender				
Male	19	54	73	72
Female	06	23	29	28
Total	<b>25</b>	<b>77</b>	<b>102</b>	<b>100.00</b>
2. Work experience				
up to 10 yr	06	05	11	11
11–20 yr	11	39	50	49
21–30 yr	04	28	32	31
more than 30 yr	04	05	09	09
Total	<b>25</b>	<b>77</b>	<b>102</b>	<b>100.00</b>
3. Field of specialization				
internal medicine	15	34	49	48
preventive medicine	03	12	15	14
surgery	04	13	17	17
pediatrics	00	08	08	08
psychiatry	03	10	13	13
Total	<b>25</b>	<b>77</b>	<b>102</b>	<b>100.00</b>

Site A refers to Kochi prefecture where the first training session took place; Site B: refers to Ehime prefecture where the second training session took place. The table shows that internal medicine was the specialty that was best represented, 48% of participants, followed by surgery, 17%, preventive medicine, 14%, psychiatry, 13% and pediatrics, 8%.

exposure. This set of test-radiographs was used to assess physicians' reading skills in interpreting pneumoconiotic radiographs. Of those 12 test radiographs, nine were pathological (six had plaques) and three were normal. To read the films, readers used viewboxes on which test-radiographs were displayed during the reading tests.

#### Description of methods

##### a) Study design, pre and post-tests

This study was an intervention trial whose objective was to assess the effectiveness of the two-hour training in pneumoconiosis on improving inexperienced physicians' skill in interpreting pneumoconiosis CXR (Fig. 1).

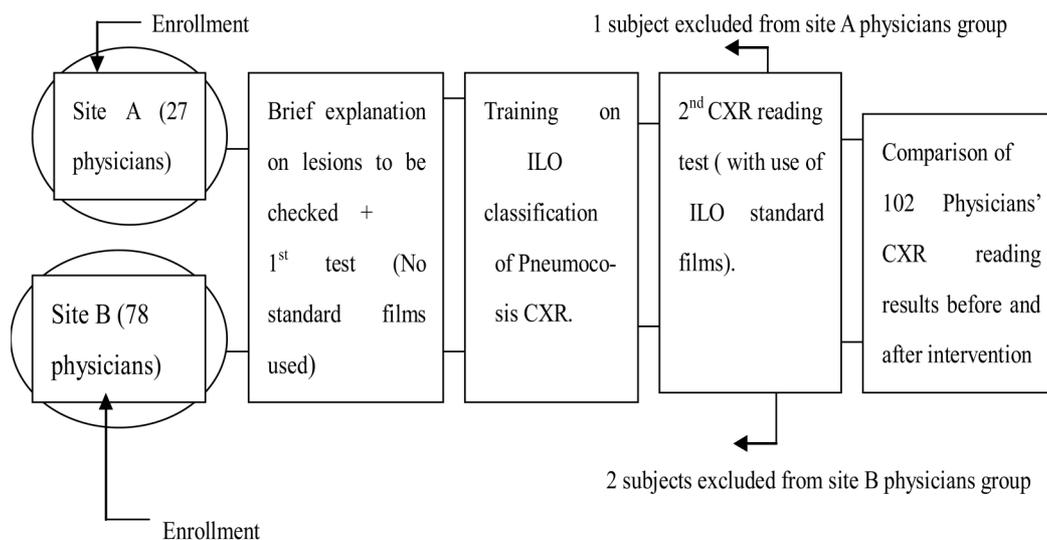
Participants were asked to listen to a pre-session talk before the main lecture I which explanations of pneumoconiotic lesions (parenchymal small opacity, pleural plaque) to be checked in the test radiographs were delivered. In order to simplify the process of description, participants only had to circle Yes or No (Yes=presence or No=absence of small opacity, pleural plaque) for each of the test radiographs, as detecting lung parenchymal and pleural abnormalities is a crucial step in pneumoconiosis CXR reading. Detailed classification of profusion of small opacities was not demanded of the participants as classifying radiographs according to the ILO/ICRP was not the object of this study.

Reading sheets were collected and managed by one of the authors of this paper that knew none of the physicians taking part in this study. The subjects were anonymously coded for the analysis of the intervention tests (pre- and post-test) results.

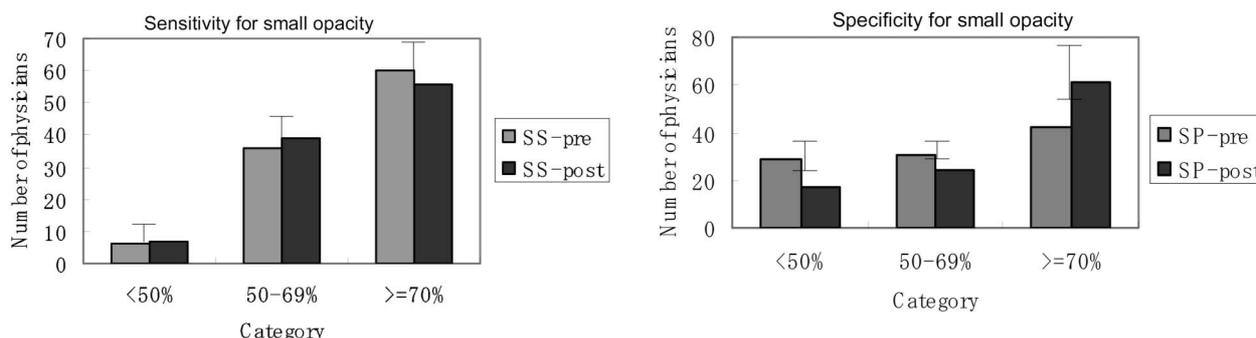
##### b) Statistical evaluation

Descriptive analyses were performed with the mean and percentages of sensitivity and specificity, and McNemar's chi square as a statistical test; the *p*-values were two-sided. Analyses were performed using STATA software version 8. After collecting all readers' data, the overall sensitivity and specificity for all readers were determined for *small opacity* and *pleural plaque* by comparing their reading results with those of the B reader, verified by CT diagnosis, for the same dust-exposed individuals.

Values of sensitivity and specificity equal to or greater than 70% were considered good, 50–69% acceptable, and less than 50% as poor. Fisher's exact test was performed to compare the number of physicians with good sensitivity and specificity for *small opacity* and *pleural plaque* in pre and post-intervention reading tests. McNemar's chi-square test was used to evaluate the significance of the difference of overall physicians' reading skill before and after the intervention. Figures were developed with the use of Excel software (Microsoft, Chicago, USA).



**Fig. 1.** Study design for assessing physicians’ skill in interpreting pneumoconiosis CXR. The final sample size was 102 physicians as three doctors who did not fully fill in their reading sheets (two from site A and one from site B) were excluded.



**Fig. 2.** Distribution of number of physicians according to categories of sensitivity and specificity for *small opacity*. SS=sensitivity; SP= specificity; Pre=pre-test; Post=post-test.

**Results**

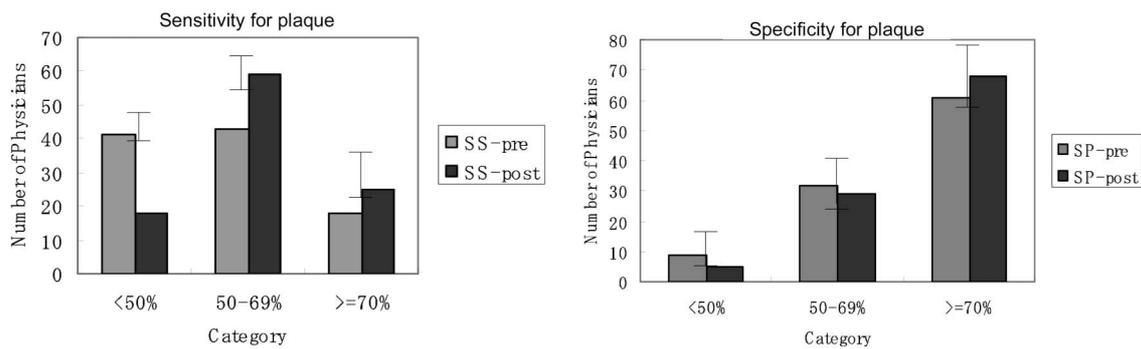
Overall sex ratio for females to males was 1:3 and the participants to this study had different backgrounds: internal medicine (48.0%), surgery (16.7%), preventive medicine (14.6%), psychiatry (12.7%) and pediatrics (8.0%). The mean value of readers’ work experience in the medical field was 19 yr and only four physicians had attended a workshop on pneumoconiosis in their career.

In this study, a general trend was seen towards improvement of physicians’ pneumoconiosis chest radiographs reading skill. However, intra- and inter-reader variations were noted in pneumoconiosis CXR reading results of the pre and post-tests, a situation that sometimes occurs even among experienced readers<sup>16-19</sup>.

An increase that was not statistically significant in the number of physicians with a good specificity score was noted for detection of *small opacity*, 42% and 60% in pre and post-test, respectively ( $p>0.05$ ), while a slight, but not significant decrease in number of physicians with good sensitivity scores was noted, 59% and 55% of physicians in pre- and post-test, respectively ( $p>0.05$ ) (Fig. 2).

Regarding the detection of *small opacity*, a significant increase of mean specificity, 65% and 73% in pre- and post-test, respectively, was observed ( $p<0.0001$ ). The mean sensitivity score remained high but slightly decreased, 84% and 81% in pre- and post-test respectively (Table 2).

For the variable *pleural plaque*, the number of



**Fig. 3.** Distribution of number of physicians according to categories of sensitivity and specificity for *pleural plaque*. SS=sensitivity; SP=specificity; Pre=pre-test; Post=post-test.

**Table 2.** Overall distribution of mean sensitivity and mean specificity of all readers for small opacity and pleural plaque (N=102)

Lung abnormality	Mean sensitivity		<i>p</i>	Mean specificity		<i>p</i>
	pre-test	post-test		pre-test	post-test	
Small opacity	84%	81%	0.204	65%	73%	< 0.0001*
Pleural plaque	46%	60%	< 0.0001*	77%	79%	0.3339

\*: *p*-value significant by McNemar's chi-square test ( $p < 0.05$ ). Statistically significant increase of overall mean specificity for detection of *small opacity*, 65% in pre-test and 73% in post-test ( $p < 0.0001$ ) and mean sensitivity score for *pleural plaque*, 46% and 60% ( $p < 0.0001$ ) in pre- and post-test, respectively.

**Table 3.** Distribution of mean sensitivity and mean specificity of all readers, for small opacity and pleural plaque, according to medical specialty (internists and other physicians,  $n=49$  and  $n=53$ , respectively)

Group of readers	Lung lesions	Mean sensitivity		<i>p</i>	Mean specificity		<i>p</i>
		pre-test	post-test		pre-test	post-test	
Internists	Small opacity	83%	78%	0.2087	67%	76%	0.0030*
	Pleural plaque	41%	61%	0.0000*	83%	80%	0.21
Other specialties	Small opacity	85%	83%	0.5465	63%	71%	0.0032*
	Pleural plaque	50%	59%	0.0101*	72%	79%	0.0186*

*p*: *p*-value by McNemar's chi square test. \*: statistically significant ( $p < 0.05$ ). For internists, significant improvements of CXR reading skill were observed for mean specificity, 67% and 76% in pre- and post-test, respectively ( $p=0.0030$ ) and mean sensitivity for *small opacity*, 41% and 61% ( $p < 0.0001$ ). For "other physicians", significant increase of mean specificity for *small opacity*, 63% and 71% ( $p=0.0032$ ), mean sensitivity for *pleural plaque*, 50% and 59% ( $p=0.0101$ ) and mean specificity for *pleural plaque*, 72% and 79% in pre- and post-test ( $p=0.0186$ ), respectively, were observed.

physicians with good specificity increased, 60% and 67%, those with good sensitivity also increased, 18% and 25%, respectively (Fig. 3).

The overall mean sensitivity for detection of *pleural plaque* increased significantly ( $p < 0.0001$ ), 46% in the pre-test and 60% in the post-test, while an improvement that was not significant was observed for mean specificity

score (77% and 79%, respectively;  $p=0.3339$ ) as presented in Table 2.

The distribution of mean sensitivity and mean specificity according to medical specialty shows relatively similar reading skills for the groups of internists and physicians from other medical specialties in pre-test (Table 3).

For internists, significant improvement of pneumoconiotic CXR reading skill was observed regarding mean specificity for small opacity, 67% and 76% in pre- and post-test, respectively ( $p=0.0030$ ), and mean sensitivity for *pleural plaque*, 41% and 61% respectively ( $p<0.0001$ ). For the group of other physicians, significant increases for mean specificity were observed for *small opacity*, 63% to 71% ( $p=0.0032$ ), mean sensitivity for *pleural plaque*, 50% to 59% ( $p=0.0101$ ), and mean specificity for *pleural plaque*, 72% to 79% ( $p=0.0186$ ) in pre- and post-test, respectively (Table 3).

## Discussion

This intervention trial highlighted the education effect of short training (two hours) about the basics of CXR reading of pneumoconioses, especially the detection of small opacities and pleural plaques for asbestos-related diseases. The number of readers with good specificity for *small opacity* increased by 19% in post-test, and increases of 7% were observed for both good specificity and good sensitivity for *pleural plaque* (data not shown). The slight decrease in the number of physicians with good sensitivity scores for *small opacity* that was observed can be explained by the increase in the number of those who belonged to the intermediary category (50–69%) in post-test. In addition, a simultaneous increase in the number of physicians with good specificity for *small opacity* was also noted. The accuracy rate for *small opacity and pleural plaque* increased, too 69 to 75% and 62 to 70% in pre- and post-test, respectively.

Though the test radiographs used for the pre- and post test in this study were not large in number, they showed the effectiveness of providing participatory training in reading proficiency for pleural plaques. For each of the pneumoconiotic findings, namely opacities (small rounded opacities, small irregular opacities, large opacities) and pleural abnormalities, a total of two-hour session is provided which consists of an hour each for lecture and reading sessions. The present short course was mainly devoted to the detection of asbestos-related diseases and the two-hour training seemed sufficient for improving the physicians' skill in detecting pleural plaques on pneumoconiotic CXR. The duration for usual pneumoconioses radiographs reading workshops is three to five days and includes other public health issues related to pneumoconioses. That is often too costly and time-consuming for physicians to attend.

Besides, the uniqueness of this training program is that despite being carried out in a relatively short-time, it resulted in a noticeable improvement in physicians' skill in reading pneumoconiotic chest radiographs. A study conducted by Morgan<sup>20</sup> showed that internists are more likely to have better adaptation skills for pneumoconiotic CXR reading after training than other physicians, especially among the test takers for the NIOSH B reader

examination. Conversely, this study did not show a significant difference between the two groups in terms of reading skill improvement. Physicians from other specialties showed a relatively better reading skill improvement compared to internists, particularly for the mean specificity score for *pleural plaque*. Concerning *small opacity*, no significant difference was observed between the two groups of physicians, and they both had a slight decrease in mean sensitivity, though it remained high.

In Japan, the Pneumoconiosis Law requires employers with potentially dusty workplaces to have their employees undergo periodical medical checks including chest radiography<sup>21</sup>. Current and ex-workers with asbestos exposure are subjected to chest radiograph screening at six-month intervals regulated by the Ordinance for Prevention of Health Impairment due to Asbestosis in Japan. However, there are still many workers and ex-workers who are not covered by these regulations. For instance, workers in small scale industries and self-employed contractors visit hospitals and private clinics without knowledge of their past exposure to asbestos. Training more physicians in pneumoconiotic radiograph interpretation would contribute to identification and care for more workers and even inhabitants exposed to dust who may develop pneumoconiosis.

As the prevalence of lung cancer is said to correlate with asbestosis, early detection of asbestosis related lung diseases may improve the prognosis and chances of survival for subjects exposed to asbestos<sup>22, 23</sup>.

In a survey conducted at an asbestos composite factory in Mumbai, India, Murlidhar and Kandhere stressed the lack of training of doctors in the diagnosis of occupational diseases as the main factor leading to the misdiagnosis of asbestosis as either chronic bronchitis or tuberculosis<sup>24</sup>. This is also true for many other low-income countries across Asia and Africa where occupational safety and health is a neglected concept and workers are often exposed to harmful substances without protection from appropriate safety equipment.

This study has some limits. Despite the availability of ILO standard films, the number of view-boxes was limited to a dozen in a conference room holding 27 or more physicians, and physicians had to move from one radiograph to another. Also, the number of test-radiographs was relatively small, therefore could not guarantee a noticeable improvement of physicians' pneumoconiotic CXR reading skill. However, the test radiographs were selected by an expert, so that 75% would be abnormal and 25% normal, and to show different radiologic features consistent with asbestosis.

In addition, instead of a random sampling of physicians at their workplace, physicians from Japanese medical associations were invited, through their respective organizations, to voluntarily attend the training programs

at two different locations. This sampling process could have been a source of bias. Despite these limitations, it is evident that the reading skill improvement observed in this study was the result of the short-term intervention (both the pre-session and main lecture) as almost all participants had very little knowledge of pneumoconiosis radiographic diagnosis prior to the training session.

In conclusion, this study showed that the two-hour participatory training enhanced inexperienced physicians' skill in interpreting pneumoconiotic CXR. There are still countries without pneumoconiosis medical screening programs despite the WHO/ILO call for worldwide cooperation to eliminate it. Although the two-hour course cannot replace the usual five days ILO training workshop, this program may be useful for improving physicians' skill in the diagnosis of pneumoconiosis in areas with evident environmental or occupational exposure to dust.

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