CHANGES IN COMPENSATION FOR OCCUPATIONAL LUNG DISEASE IN BRITAIN OVER 34 YEARS

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ABSTRACT

Silicosis was the first occupational lung disease to be made compensatable in Britain by legislation in 1919. This was followed by asbestosis in 1931, byssinosis in 1941 and coalworkers pneumoconiosis (CWP) in 1943. More recent additions were mesothelioma in 1966, occupational asthma in March 1982 and two asbestos related diseases in April 1985. (1) Primary carcinoma of the lung accompanying asbestosis and/or bilateral diffuse pleural thickening. (2) Bilateral diffuse pleural thickening. A claim is entertained if it relates to a prescribed disease. A disease may be prescribed only if it is a risk of occupation, and the occupational link can be established or presumed with reasonable certainty in individual cases.

There has been a steady decline in CWP and silicosis with an increase in asbestos related diseases. Thus there were 325 cases of CWP diagnosed in 1987 compared to 357 in 1986, 402 in 1983, 683 in 1985, 937 in 1966 and 4,449 in 1954. Asbestosis was diagnosed in 247 cases in 1987 compared to 312 in 1986, 199 in 1983, 161 in 1975, 114 in 1966 and 31 in 1954. The age at which these conditions were first diagnosed has also increased. A total of 399 cases of mesothelioma presented in 1987 compared to 441 in 1986, 413 in 1984, 282 in 1980 and 212 in 1977. Occupational asthma was found in 199 subjects in 1987 compared to 166 in 1986 and 183 in 1983. Bilateral diffuse pleural thickening was present in 115 cases in 1987 compared to 111 cases in 1986 and 61 in 1985.

The occupational lung diseases eligible for compensation (or benefit) payable by the state in Britain (prescribed respiratory diseases) include, among other conditions, coalworkers pneumoconiosis (CWP), asbestosis, silicosis, diffuse mesothelioma, byssinosis and occupational asthma. A claim for compensation can only be considered if it relates to a prescribed disease and the person concerned has been employed as an insured person under the state scheme in an occupation prescribed for the disease. A disease may be prescribed if (a) it is a risk of occupation and not a risk common to all and (b) the occupational link in individual cases can be established or presumed with reasonable certainty. A committee of experts, the Industrial Injuries Advisory Council, advises the Secretary of State whether a disease should be prescribed. The prescribed occupations for pneumoconiosis and related conditions are set out in full in the Social Security Act of 1975. The diagnosis of these diseases and the assessment of the resulting disablement is made by doctors with special experience of chest diseases employed by the Department who are stationed at eight centres in various parts of Britain.

In 1897 the first Workmens Compensation Act came into force, which gave workmen the right to compensation for accidents at work. This was funded by employers. It was not until 1919 that provision was made under this Act in respect of disablement or death due to silicosis in certain occupations. Following the report of Merewether and Price to Parliament in 1930, the asbestos industry (asbestosis) scheme was introduced in 1931, which made compensation available for asbestosis for the first time. The publication in 1942 of a Medical Research Council report on chronic pulmonary disease in coalminers showed that these men were liable to a form of pneumoconiosis which could not be regarded as true silicosis. This led to the passing of the Workmens Compensation Act 1943, which covers all forms of pneumoconiosis, as defined in the Act. The definition adopted was "Fibrosis of the lungs due to silica dust, asbestos dust or other dusts, including the condition of the lungs known as dust reticulation."

The whole scheme has replaced the Industrial Injuries Act in July 1948, which provided state benefit for the first time for all forms of pneumoconiosis in relation to a list of scheduled occupations. These regulations were amended in 1954 to enable unscheduled occupations involving exposure to dust to be covered. In August 1956, primary malignant neoplasm of the pleura or peritoneum (diffuse mesothelioma) was included in the list of prescribed diseases, and in October 1983, the word "malignant" was dropped and the pericardium was added to the pleura and peritoneum. In March 1982, occupational asthma was added to the list of prescribed diseases in relation to the seven agents, i.e. (1) isocyanates, (2) platinum salts, (3) fumes or dusts arising from the use of hardening agents, including epoxy resins, (4) fumes arising from rosin used as a soldering flux, (5) proteolytic enzymes, (6) animal

or insects used for research, education or in laboratories, (7) dusts arising from barley, oats, rye, wheat or maize or to dusts arising from meal or flour made from these substances. Seven more agents were added to this list in September 1986; antibiotics, cimetidine, wood dust, ispaghula, castor bean dust, ipecacuanha, and azodicarbonamide. Two asbestos-related diseases were prescribed in April 1985. (1) Primary carcinoma of the lung where there is accompanying evidence of asbestosis and/or bilateral diffuse pleural thickening; (2) Bilateral diffuse pleural thickening. The latest occupational lung disorder to be prescribed was lung cancer in those who have been in an occupation involving (a) work underground in a tin mine; or (b) exposure to bis(chloromethyl)ether produced during the manufacture of chloromethyl methyl ether; or (c) exposure to zinc chromate, calcium chromate or strontium chromate in their pure forms.

The general pattern over the years has been that of a steady decline in the incidence of coalworkers pneumoconiosis and silicosis with an increase in asbestos-related diseases. The diseases now tend to present in less severe forms and the average age at diagnosis has increased. Thus the average age of diagnosis in coalworker pneumoconiosis in 1987 was 69 years, compared to 57 years in 1968. These changes are shown in some detail in the accompanying tables. These show that only 325 cases of CWP were diagnosed in 1986 compared to 4,449 in 1954, while asbestosis was diagnosed in 247 cases in 1987 compared to 31 in 1954. 399 cases of mesothelioma presented in 1987 compared to 212 in 1977. Occupational asthma was found in 199 subjects in 1987 compared to 183 in 1983 and bilateral diffuse pleural thickening was present in 115 cases in 1987 compared to 61 in 1985.

These figures do not reflect the true evidence of the condition, as when carcinoma occurs in a known case of asbestosis, it is often financially advantageous to the patient to have this regarded as a complication of asbestosis.

Table I

Newly Diagnosed Cases of Pneumoconiosis (Prescribed Disease D1)
According to Year and Industry (Industrial Injuries Scheme)

INDUSTRY	1954	1960	1966	1972	1975	1978	1981	1983	1985	1986	1987
Coalworkers	4,449	3,279	937	626	683	476	493	402	364	357	325
Asbestos workers	31	29	114	125	161	128	140	199	273	312	247
Other mines and quarries	113	86	57	42	41	54	39	10	7	23	27
Foundry workers	256	99	55	40	31	29	13	19	18	19	19
Steel dressers	106	19	18	11	8	5	3	0	6	2	2
Pottery manufacture	345	50	27	24	24	10	10	14	14	10	18
Refractories	26	16	14	8	9	5	5	5	3	6	3
Other industries	156	76	42	43	24	37	31	21	54	44	34
TOTAL	5,482	3,654	1,264	919	981	744	734	670	739	773	675

Table II

Coalworkers Pneumoconiosis—Newly Diagnosed Cases Analysed by Age and Year of Diagnosis

	Under 35 yrs	35–44 yrs	45–49 yrs	50–54 yrs	55–59 yrs	60–64 yrs	65 yrs & over	TOTAL
1955	199	677	746	1016	924	804	591	4997
1961	43	345	378	505	604	599	289	2768
1968 (average age 57)	7	76	92	127	161	184	127 (a)	774
1975 (average age 61)	2	22	28	73	131	139	288 (b)	683
1979 (average age 62)	–	12	15	67	144	86	214 (c)	538
1983 (average age 64)	–	9	18	31	88	65	191 (d)	402
1987 (average age 69)	–	3	7	18	17	46	234 (e)	325

(a) includes 20 aged over 75
(b) includes 63 aged over 75
(c) includes 62 aged over 75
(d) includes 70 aged over 75
(e) includes 98 aged over 75

Table III

Asbestosis—Newly Diagnosed Cases Analysed by Age and Year of Diagnosis

	Under 35 yrs	35–44 yrs	45–49 yrs	50–54 yrs	55–59 yrs	60–64 yrs	65 yrs & over	TOTAL
1961	-	5	11	8	5	9	5	43
1968 (average age 55)	1	17	17	28	22	31	14 (a)	130
1975 (average age 58)	-	11	19	25	35	39	32 (b)	161
1979 (average age 59)	-	5	9	22	45	21	21 (c)	123
1983 (average age 61)	-	4	15	30	45	35	70 (d)	199
1987 (average age 63)	-	4	11	17	39	59	117 (e)	247

(a) include 1 aged over 75
(b) includes 4 aged over 75
(c) includes 1 aged over 75
(d) includes 16 aged over 75
(e) includes 26 aged over 75

Table IV

Mesothelioma Cases Diagnosed According to Year

1966 - 76	1977	1980	1983	1984	1985	1986	1987
1,109	212	282	312	413	405	441	399

Table V

Occupational Asthma—PD D7

Newly Diagnosed Cases Analysed by Agent and Year of Diagnosis

	1983	1984	1985	1986	1987	TOTAL
ISOCYANATES	74	51	46	48	47	266
PLATINUM SALTS	9	4	9	12	10	44
HARDENING AGENTS	12	14	19	28	18	91
SOLDERING FLUX	24	27	25	20	22	118
PROTEOLYTIC ENZYMES	3	1	6	0	5	15
ANIMALS/INSECTS	7	8	7	12	7	41
FLOUR GRAIN	54	32	54	46	41	227
ANTIBIOTICS	0	0	0	0	30	30
CIMETIDINE	0	0	0	0	0	0
WOOD DUST	0	0	0	0	15	15
ISPAGHULA	0	0	0	0	0	0
CASTOR BEAN DUST	0	0	0	0	0	0
IPECACUANHA	0	0	0	0	0	0
AZODICARBONAMIDE	0	0	0	0	4	4
TOTAL	**183**	**137**	**166**	**166**	**199**	**851**

Table VI

Lung Cancer Accompanied by Asbestosis or Bilateral Diffuse Pleural Thickening (Prescribed Disease D8)
Cases Diagnosed According to Year

1985	1986	1987	TOTAL
8	34	55	97

Table VII

Bilateral Diffuse Pleural Thickening (Prescribed Disease D9)
Cases Diagnosed According to Year

1985	1986	1987	TOTAL
61	111	115	287

INTEROBSERVER VARIABILITY USING THE ILO (1980) CLASSIFICATION IN SUBJECTS REFERRED FOR COMPENSATION EVALUATION

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INTRODUCTION

It is estimated that several million persons were occupationally exposed to asbestos between 1940 and the late 1970s.[6] Accurate identification of those with asbestos-associated conditions leading to premature morbidity and/or mortality is necessary from medical, legal and social-ethical standpoints.

The chest radiograph assumes a central role in the evaluation of different lung dust diseases, particularly in the earlier stages when symptomaticity and spirometric changes may be minimal or absent. However, the radiograph is subject to a good deal of both intra and interobserver differences in interpretation. The causes of this variability may be multifactorial, and may include film quality, experience in the interpretation of certain radiographic patterns and prevalence of abnormalities on the chest roentgenogram. We addressed some of these issues in a group of asbestos-exposed subjects referred for compensation evaluation.

STUDY OBJECTIVES

The purposes of this study were:

a) to assess and quantitate interobserver agreement among experienced readers on certain features of the 1980 ILO Classification of Radiographs of the Pneumoconioses, in a population with a high prevalence of radiographic abnormality;

b) to assess and quantitate the effect of suboptimal radiographic technique on this interobserver agreement.

MATERIALS AND METHODS

Study Population

The study population was composed of all subjects consecutively referred to our facility for evaluation of possible asbestos-associated conditions between July 1, 1981 and June 30, 1986. All were from Southeast Texas, an area where numerous petrochemical industries and shipyards are located. All were either active or former asbestos end-product users or their immediate family members.

Radiographs

All study subjects underwent a uniform evaluation consisting of a history, physical examination, full resting and exercise pulmonary function testing and chest radiography. Standard 14 × 17 inch radiographs (posteroanterior, lateral and bilateral oblique views) were taken in full inspiration at a distance of 72 inches, using high-kilovoltage technique at The Methodist Hospital in Houston.

Interpretation of Radiographs

Radiographs were interpreted independently by 3 NIOSH-certified 'B' readers who were unaware of the subjects' identities and histories. Readings were carried out with the radiographs in an unknown order, during three separate batch sessions over a twelve month period, using standard radiographs for comparison. The readers were asked to identify any films that were of less than optimum quality. Profusion scores were based only on the posteroanterior views, and each radiograph was read into one of the 12 ILO minor profusion categories. Later, for purposes of analysis, the profusion scores were grouped into the four major ILO profusion categories, 0 to 3. Pleural readings were based on the posteroanterior views, although the use of the other three views for confirmation was permitted. The pleural endpoints determined in the analysis were: pleural thickening (presence versus absence), width of pleural thickening along the chest wall, pleural calcification (presence versus absence) and extent of pleural calcification, as defined by the 1980 ILO Classification of the Radiographs of the Pneumoconioses.

Statistical Analysis

The degree of interobserver agreement was determined by kappa-type analysis, in order to account for agreement expected on the basis of chance alone. Kappa-type analyses are generally based on the following equation:

$$\bar{k} = \frac{P_o - P_e}{1 - P_e},$$

Where $\bar{k}$ is the kappa statistic, P_o the observed proportion of agreement among the readers, and P_e the proportion of agreement based on chance.

The equations specifically employed in this study were taken from Fleiss, who addresses the calculation of $\bar{k}$, its standard error (S.E.$\bar{k}$) and testing of the significance of $\bar{k}$; these equations are summarized in Table I.[2]

Kappa values are greater than 0 only when observed agreement exceeds that attributable to chance alone. The maximum possible value is 1.0. In general, kappa values between 0.81 and 1.0 indicate near perfect agreement; values in the 0.61 to 0.80 range, excellent agreement; 0.41 to 0.60, good agreement; 0.21 to 0.40, fair agreement, and values between 0.00 and 0.20, minimal agreement beyond chance alone.[2,4]

Table I
Equations Used in Kappa-type Analysis

Calculation of overall kappa statistic:

$$\bar{k} = 1 - \frac{nm^2 - \sum_{i=1}^{n} \sum_{j=1}^{k} x^2_{ij}}{nm(m-1) \cdot \sum_{j=1}^{k} \bar{p}_j \cdot \bar{q}_j}$$

Calculation of the standard error of the overall kappa:

$$S.E.(\bar{k}) = \frac{\sqrt{2}}{\sum_{j=1}^{k} \bar{p}_j \cdot \bar{q}_j \sqrt{nm(m-1)}} \sqrt{\left(\sum_{j=1}^{k} \bar{p}_j \cdot \bar{q}_j\right)^2 - \sum_{j=1}^{k} \bar{p}_j \cdot \bar{q}_j \, (\bar{q}_j - \bar{p}_j)}$$

Test of significance:

$$Z = \frac{\bar{k}}{S.E.(\bar{k})}$$; Z is then referred to tables of the standard normal distribution.

Equations were taken from Fleiss for determination of kappa and its standard error when the number of readings per study subject is constant. (2)

Legend: $\bar{k}$ = kappa; n = no. of study subjects; m = no. of readings per subject; x_{ij} = the number of readings on subject i (i = 1, ...n) into category j (j=1, ...k); $\bar{p}_j$ = overall proportion of readings in category j; $\bar{q}_j = 1-\bar{p}_j$.

RESULTS

Descriptive Statistics (Table II)

A total of 469 subjects with a complete set of radiographs were identified over the five year period. Of these, 417 gave a history of asbestos exposure; the remaining 52 had, in addition to asbestos exposure, a variable history of silica exposure through sandblasting or spraypainting. The mean age (+/- S.D.) was 55.9 +/- 9.95 years, with an average of 32.6 +/- 9.3 years since onset of first exposure to asbestos and of 27.9 +/- 10.7 years in the trade.

Profusion

The three readers agreed within +/- one minor profusion category of each other on 67% of radiographs. Table III shows the proportion of films read into each major profusion category by the individual readers. Reader 3 classified a higher proportion of films in category 1 than the other two readers; however, when broken down by minor profusion category, the discrepancies were mainly in the 0/0 to 1/0 range (data not shown).

The overall kappa statistic for agreement among the three readers (Table IV) by major profusion category was 0.44 +/- .02 ($p < .001$). The individual kappas for each category were: category 0, 0.47 +/- .03; category 1, 0.42 +/- .03; category 2, 0.41 +/- .03 and category 3, 0.42 +/- .03, all $p < .001$.

Pleural Thickening

Table III shows the proportion of radiographs felt to show evidence of pleural thickening, and its width, by individual reader. Again, Reader 3 classified a greater proportion of films as being consistent with pleural thickening, as compared to the other two readers. The overall kappa statistic (Table IV) for agreement on the presence of pleural thickening was 0.50 +/- .03 ($p < .001$). Interobserver agreement on the width of pleural thickening, when present, was only fair, with a kappa of 0.35 +/- .02 ($p < .001$). Individual kappa values by each width category were: category a (1-5 mm in width), 0.25 +/- .03; category b (> 5-10 mm), 0.24 +/- .03, and category c (> 10 mm) 0.38 +/- .03.

Pleural Calcification

The readers showed evidence of excellent agreement on the presence of pleural calcification, with a kappa of 0.62 +/- .03. Agreement on the extent of pleural calcification when present, was good, with a kappa value of 0.48 +/- .02 ($p < .001$).

Influence of Suboptimal Film Quality

Thirty-seven radiographs (7.9%) were considered to be of less than optimum quality by at least one reader. Separate kappa analysis for profusion and pleural changes was performed on this subgroup in order to assess the influence of film quality. A marked drop in all kappa values was observed. Agreement on profusion (major category) was 0.29 +/- .09 ($p < .01$). For presence of pleural thickening, kappa was 0.32 +/- .09 ($p < .001$), and for width of pleural thickening, 0.29 +/- .06 ($p < .001$). Interobserver agreement on the presence and extent of pleural calcification was likewise much lower, with kappa statistics of 0.40 +/- .09 and 0.27 +/- .08, respectively ($p < .001$).

Table II
Study Population: Descriptive Statistics

N	469
Asbestos exposure	417
Asbestos & silica exposure	52
Age	55.9 +/- 9.95
Years since onset of first asbestos exposure	32.6 +/- 9.3
Years in trade	27.9 +/- 10.7

(1) Mean +/- S.D.

Table III
Interobserver Agreement: Marginal Proportions

	ILO Category			
Profusion	0	1	2	3
Reader 1	0.62	0.33	0.04	0.01
Reader 2	0.64	0.31	0.04	0.01
Reader 3	0.46	0.50	0.03	0.01
Pleural thickening (width)	0	a	b	c
Reader 1	0.44	0.37	0.15	0.04
Reader 2	0.41	0.35	0.14	0.10
Reader 3	0.29	0.38	0.20	0.13
Pleural calcification (extent)	0	1	2	3
Reader 1	0.75	0.21	0.04	0.004
Reader 2	0.84	0.08	0.06	0.02
Reader 3	0.84	0.10	0.04	0.02

Table IV
Interobserver Agreement: Kappa Analysis

	$\bar{k}$	S.E.($\bar{k}$)	p value
Profusion (major category)	0.44	0.02	<.001
Category 0	0.47	0.03	<.001
Category 1	0.42	0.03	<.001
Category 2	0.41	0.03	<.001
Category 3	0.42	0.03	<.001
Pleural thickening			
Presence versus absence	0.50	0.03	<.001
Width	0.35	0.02	<.001
a (1-5 mm)	0.25	0.03	<.001
b (> 5-10 mm)	0.24	0.03	<.001
c (> 10 mm)	0.38	0.03	<.001
Pleural calcification			
Presence versus absence	0.62	0.03	<.001
Extent	0.48	0.02	<.001

DISCUSSION

The existence of both intra and interobserver variability among readers interpreting radiographs for the presence of pneumoconiotic changes is well recognized.[5,8,9,10] The creation, and subsequent modifications, of different classification schemes for these interpretations have had several objectives. Among these, to provide a common language with which to describe specific radiographic changes, and to reduce variability and enhance the reliability of these readings. The 1980 ILO Classification is widely used for these purposes.[3]

Factors felt to influence variability include familiarity with the classification schema, radiographic technique and overall radiograph abnormality rate. Prior studies have shown that interobserver variability is lower among experienced readers.[9] The effect of suboptimal radiographic technique on interobserver agreement has been somewhat more difficult to measure, with conflicting findings.[7,8]

Whenever two or more raters independently classify the same set of radiographs, a certain degree of agreement can be expected to result on the basis of chance alone. Chance-based agreement can be calculated,[7] and depends on the distribution of the radiographs into the different categories (i.e., marginal proportions). Thus, for example, if the abnormality rate is very low, a substantial amount of chance-based agreement can be anticipated; if the abnormality rate is higher, chance-based agreement decreases. Different approaches have been employed to adjust for this phenomenon, such as standardization of observed agreement to a certain abnormality rate.[9] Kappa-type analysis has been described as a statistical approach to the measurement of interrater agreement, particularly in the area of psychology research.[2] More recently, at least two studies have appeared where this technique was applied to the assessment of interobserver agreement in the classification of pneumoconiotic changes on chest roentgenograms. Musch et al,[7] in a study of 1771 active taconite workers, found that the kappa value for three reader agreement on profusion (major category) was 0.26. In their study, the overall abnormality rate was quite low, and a substantial amount of chance-based agreement was felt to be present. The authors also noted that film quality and film age adversely affected kappa. Zoloth et al[11] measured agreement among non-specialists and experienced readers in the screening of sheet metal workers for asbestos-associated radiographic changes. Agreement among specialists on the presence of 'asbestosis' ($\bar{k} = 0.38$) was much better than when non-specialists and specialists were compared ($\bar{k} = 0.26$). Agreement on pleural abnormalities was even lower between these two groups ($\bar{k} = 0.14$).

We applied kappa-type analysis to measure interobserver agreement, using the 1980 ILO Classification, in a referred population where the prevalence of radiographic abnormality was likely to be high. The readers were experienced in the use of this classification schema, and assessment of film quality was included. Overall agreement on profusion was good; furthermore, breakdown by each major profusion category showed a fairly uniform level of agreement across all categories. Agreement on the presence of pleural thickening, likewise, was good, and was excellent for detection of pleural calcification. However, concordance on the width of pleural thickening was only fair ($\bar{k} = 0.35$), particularly in the lower width categories. This contrasted with good agreement on extent of pleural calcification ($\bar{k} = 0.48$). Few studies have addressed interobserver agreement on pleural abnormalities. Rossiter[9] found that, among 12 readers, the prevalence of pleural thickening varied widely; variation was least for pleural calcification. Zoloth et al,[11] as previously noted, found a very poor level of agreement on pleural changes. In our study it is possible that a better level of agreement was found, not only because of the use of experienced readers, but also because they had access to oblique and lateral views for confirmation.

Suboptimal film quality had a marked effect on agreement in this study, with respect to both profusion and pleural changes. Although earlier on this detrimental effect had been difficult to demonstrate,[8] more recently Musch et al, using kappa analysis, were able to measure it; our findings are consistent with this latter study.[7]

In summary, overall agreement among experienced readers using the 1980 ILO Classification in a referred population appears to be good for profusion and pleural thickening presence, and excellent for the detection of pleural calcification. Interobserver agreement on width of pleural thickening, when present, however, is only modest and highlights an area where further efforts may need to be directed to reduce variability.

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LEGAL REQUIREMENTS FOR MEDICAL SURVEILLANCE OF ASBESTOS WORKERS IN MALAYSIA, THE USA AND UNDER INTERNATIONAL LAW

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INTRODUCTION

Worldwide, regulatory actions have consistently required medical surveillance for occupational exposure to asbestos. Regulatory agencies use "medical surveillance" as a method of verifying the effectiveness of engineering controls to prevent work-related disease. In many countries it is also used to detect longitudinal changes in the prevalance and incidence of occupational disease in light of stated regulatory goals. It is therefore an important component of regulatory programs designed to avert and curtail asbestos-related occupational disease.

In 1986, the International Labor Organization (ILO) drafted C.162, "Convention Concerning Safety in the Use of Asbestos"; Malaysia promulgated "Asbestos Process Regulations (1986)" under the Factories and Machinery Act; and the USA revised its "Occupational Safety and Health Act, Occupational Exposure to Asbestos, Tremolite, Anthophyllite and Actinolite, (1986)." One can infer from these and other developments around the world that there is a strong international regulatory trend towards increased protection against occupational exposure to asbestos. This article examines in detail the regulatory requirements for medical surveillance of asbestos workers (excluding worker's compensation) under laws in Malaysia and the USA, using the ILO Convention 162 as an analytical framework. For the purposes of this paper, "medical surveillance" of asbestos workers refers to monitoring of workers' health, as contemplated by C.162, Part IV, Article 21 "Surveillance of the Working Environment and Workers' Health." C.162 Article 21 provides that medical surveillance shall be comprised of five components: (1) medical examinations; (2) monitoring at no cost to workers; (3) information and "individual advice" to workers regarding results of medical examinations; (4) alternative sources of income for those workers for whom asbestos exposure is "medically inadvisable"; (5) a notification system for asbestos-related disease. C.162 allows for expansive protections of exposed workers, through its medical surveillance requirements. Even though many important components of the program are not expressly stated, the key elements of a good program are included within its purview. C.162 therefore is a good blueprint for evaluating medical surveillance programs.

GENERAL BASIS FOR STATUTORY PROTECTIONS

Regardless whether a given regulatory body is a national government or an international organization, standards within a legal system must not be arbitrary and capricious and must be consistent with the constitutional and practical legal norms within the national or international context. All three of the bodies of law discussed herein fall within the purview of the organization's authority in their respective legal contexts. For example, the ILO Constitution's Preamble considers occupational health is a fundamental human right.[1] By ratifying the ILO Constitution member states grant ILO the authority to promote interaction and coordinated activity between employers, workers and governments and to foster dialogue between less developed and industrialized nations. International standards like C.162 represent the synthesis of international scientific consensus with the perspective of labor, management and government. Despite the weaknesses discussed below, such standards provide a neutral and respected point of reference that can be applied in different political contexts.

Malaysian asbestos regulations have been written with foresight to diminish the likelihood of widespread illness, pursuant to authority in the Factories and Machinery Act 1967 which has jurisdiction to protect the "safety, health and welfare of persons in the workplace."[2] Section 22 of the Act provides for medical examinations of persons employed in factories where diseases in the Third Schedule (Notifiable Industrial Diseases)[3] have occurred or are likely to occur.[4] Malaysia's asbestos regulations were written pursuant to the authority to promulgate regulations for a safe and healthy work environment in Sec. 56(1).

By contrast, the USA's regulations are an outgrowth of a long, litigious history of asbestos-related disease. The USA's standard for occupational exposure to asbestos,[5] was adopted pursuant to the "Occupational Safety and Health Act of 1970" ("OSH Act").[6] OSH Act authorizes the Secretary of Labor to promulgate "occupational safety and health standards" and established the Occupational Safety and Health Administration, (OSHA) to perform this mission. OSHA standards must be "reasonably necessary or appropriate to provide safe or healthful employment or places of employment," under s3(8).[7] The US Congress' delegation of this authority to OSHA is justified under the "commerce clause"[8] of the US Constitution.[9]

MEDICAL SURVEILLANCE

Scope of Coverage

C.162 and Recommendation 172 (1986) cover all activities involving exposure of workers to asbestos. However, member

states may exclude particular branches of economic activity or particular undertakings from application of provisions of conventon after taking into account the frequency, duration and level of exposure, type of work and conditions at workplace. This provision was written with the intention of creating a flexible framework that could be adjusted to meet the needs of different workplaces in nations of differing levels of development so long as such exemptions are justified. Theoretically, this provision runs the risk of becoming an exception that swallows the rule, since variances may be granted to any number of employees or large sectors of the asbestos industry without jeopardizing the facade of compliance with international standards. This could enable member states to permit various exceptions to the rule, while still in compliance with international norms, although few if any workers would receive protection even though programs exist in concept. This is unlikely, however, given the importance of General Principles in Article 3, (Part II), where ratifying states make a commitment to implement protections through national and local legislation. Unlike older ILO standards, C.162 has no specific exposure indices. This is an advantage because implementation of recent advances are not hindered by outdated "ceilings" or exposure limits.

Malaysia's regulations "apply to all factories in which any asbestos process is used but shall not apply to any building operations or works of engineering construction." The regulations only cover asbestos process—meaning "manufacturing process involving the use, application, removing, mixing or other handling of asbestos material, excluding: 1. cleaning of premises, plant, equipment, furniture or fittings; and 2. asbestos dust dispersed but does not exceed PEL in the breathing air." The PEL is 1 fiber per ml 8 hour TWA.[10] As in C.162, use of crocidolite is banned in the workplace. The Malaysian regulations are an excellent example of comprehensive and substantive provisions for medical care to prevent occupational disease even though their scope is limited to a narrow segment of the asbestos-using portion of the economy.

The USA's federal OSHA regulations cover all occupational exposure to asbestos except in the construction industry, (covered under a separate section of the OSHA standards). This aspect of OSHA standards has been heavily litigated in the last decade, most recently in *Building and Construction Trades Department v. Brock.*[11] The court held that OSHA needed to revise its standards in relation to the building trades. Another exception to the regulations concerns employers below the "action level" (0.1 fiber/ml), even though this may not preclude regulation by state and local authorities or environmental protection agencies. This is a significant loophole in health protection; it is one that looms even larger in light of recent initiatives towards increased self-reporting by employers.

Medical Surveillance Requirements

Asbestos exposure is associated with pleural plaques, pleural calcification, pleural effusion,[12,13] asbestosis,[14,15] lung cancer,[16,17] pleural mesothelioma,[18] peritoneal mesothelioma[19] and cancers of the larynx.[20,21] Good surveillance programs for asbestos exposed individuals seek to diagnose these conditions before they manifest clinically, taking into account the latency period and natural history of disease. They also screen for existing disease and monitor the occurrence and progress of disease. According to the American Thoracic Society (ATS), the following information is necessary to make a reliable diagnosis: a reliable history of exposure; an appropriate time interval between exposure and detection; and clinical manifestation. Additionally, in cases of asbestosis, diagnostic criteria include: (1) standard chest radiographic evidence with type s, t, u, irregular opacities with profusion of 1/1 of greater classified by the ILO Classification, 1980; (2) a restrictive pattern of lung impairment with forced vital capacity below the lower limit of normal; (3) a diffusing capacity below the lower limit of normal; (4) in bilateral late or pan inspiratory crepitations at the posterior lung bases not cleared by cough.[22] C.162 enables competent authorities in member states to authorize and verify the existence of programs that include these key components.

1. Medical Examinations

C.162 provides that member states shall require medical examinations. Member states are free to determine, however, the frequency, (e.g. annual or biennial) place, (e.g. at the worksite, or in a governmental health facility); and extent of such examinations, pursuant to their respective laws. All three laws require pre-placement screening and periodic examinations, (although the length of time between examinations may vary). C.162 uniquely requires medical surveillance after termination of employment.

Malaysia and the USA similarly require that the content of medical examinations include: occupational and smoking history; physical examination; pulmonary function test and a chest radiograph. Of these two sets of regulations, the content of medical examinations in the USA is more clearly defined. A standardized questionnaire for occupational and smoking history administered during the medical examination, is useful for generating epidemiologic information. It also ensures repeatability of results over time and from one physician to another. While Malaysia has no standardized questionnaire, existing model questionnaires developed by the Medical Research Council, and Epidemiology Standardization Project could be modified for Malaysia's use.[23] By contrast, the USA's requirements include use of a standardized respiratory questionnaire, which is readily obtained by reading Appendix D of the OSHA regulations.[24]

Spirometric measurements taken during pulmonary function testing should be carried out by physicians or specially trained technicians.[25] Quality control in pulmonary function testing is important as there is large variability in instrumentation and measuring techniques.[26] In Malaysia, there are no approved training programs nor standardized criteria for pulmonary function testing. This is problematic for the implementation of the regulations. Insofar as standardization of spirometry is concerned, criteria by ATS[27] and the European Community for Coal and Steel[28] could be used. In the USA, technicians are trained to use the ATS criteria in National Institute for Occupational Safety and Health (NIOSH) approved training programs.

Detection of the severity of pneumoconiosis depends on the technical quality of the radiograph and the training and experience of the reader.[29] Ideally, films used for medical surveillance for pneumoconiosis should be read by two independent readers and if the readings differ, a third independent reading should be obtained and consensus interpretation obtained.[30] In Malaysia, there are no training programs for those physicians who read chest radiographs; and use of ILO Classification System of Radiographs, ("ILO Radiographs") is not required under this law.

According to USA law, chest radiographs shall be read by radiologist, or those with training in reading the ILO Radiographs. Pursuant to Appendix E,[31] chest roentgenograms "shall be interpreted and classified in accordance with a professionally accepted classification system and recorded on a roentgenographic interpretation form CSD/NIOSH(M) 2.8." This can only be done by: a "B reader"; a board eligible/certified radiologist; or an experienced physician with expertise in pneumoconiosis. The regulations also require all interpreters to have ILO-U/C International Classification of Radiographs of Pneumoconiosis 1980.

Preplacement examinations screen for preexisting disease, fitness to work in asbestos site, and to exclude those not fit. In Malaysia they are required within 30 days from employee commencing work in asbestos area. In the USA such exams are a requisite to assignment. Periodic medical examination monitor for disease and changes in health status of individual. C.162 requires periodic medical examinations, as determined by competent authority in member states. In Malaysia periodic medical examinations are required "at intervals not longer than 2 years"[32] while in the USA medical examinations to be made available annually.[33] Although the medical examinations are to be conducted annually in the USA, chest radiographs are carried out every 5 years for all age groups who are examined within 10 years of first exposure. For workers whose exposure began more than 10 years ago, chest radiographs are taken every 5 years if the worker is 15-35 years of age; every 2 years; if worker is 35-45 years of age; and each year for those age 45 or older. All workers must also be examined within 30 days of termination.

2. Cost of medical surveillance

All three of these pieces of legislation agree that medical examinations shall be "free of charge" to the employee.[34] C. 162 states that medical examinations take place during working hours when possible.

3. Information provided to workers

Under C.162[35] the workers should have access to "individual advice" regarding the results of their medical exams. Since C.162 does not explicitly require full disclosure by the physician, this raises issues of medical ethics if in the physician's professional judgement, full disclosure has a detrimental effect upon the worker's health. But, the absence of a requirement for full disclosure also has the potential for abuse by employers who direct the physical-employee to withhold information. Malaysian regulations require medical results to be given to the employer and employee upon the employee's request.[36] In the USA, employers must make available medical records for examination and copying to affected employees, former employees, designated representatives and the government. Implicit in the requirement that workers obtain information is an underlying concept: that physicians should have access to any or all information relevant to the health status of the worker who is the subject of medical surveillance. Both C.162 and Malaysian regulations do not expressly define the scope of information to be provided to the physician. The OSHA's "Medical Access" regulations clearly require disclosure to workers of any or all relevant information pertaining to their exposure and their medical history.[37] In addition, the asbestos regulations require the employer to give the examining physician: relevant OSHA regulations; a description of employees duties as related to exposure; a representative or anticipated exposure level; a description of any personal protective or respiratory equipment; and employees medical records, not otherwise available to the physician.

4. Alternative sources of income

The diagnosis of asbestosis does not mean impairment of lung function or physical disability is necessarily present. Many workers whose conditions are detected by medical surveillance will be capable of continuing their work in other areas of employment, without exposure to asbestos; C.162 therefore requires that workers who might not qualify for workers' compensation or social security disability benefits must be offered other means of maintaining their income.[38]

5. Notification system

C.162 requires that member states develop a notification system for asbestos related disease.[39] Factories and Machinery Act Sec. 32 requires registered medical practitioners attending to or called to visit a patient suffering from a notifiable industrial disease to send a notice to the Chief Inspector and the occupier of the factory. According to the US Regulations the physician is to provide the employer with a written opinion on the employee. The employer must then provide the employee with a copy of the written report within 30 days of receipt. Reportability of diseases in the USA is a subject matter for state, not federal jurisdiction.

CONCLUSION

Given that early detection cannot always alter the course of an exposed worker's prognosis, the validity and purpose of medical surveillance has been questioned. Notwithstanding this view, medical surveillance among asbestos workers represents a fundamental protection that has been codified in international and national asbestos standards and is an extremely useful tool for measuring compliance as well as evidence of disease in cases of torts. C.162 provides a comprehensive medical surveillance program to control occupa-

tional lung disease. While C.162 raises many issues regarding implementation, it provides a sound blueprint for good medical surveillance programs. The national laws reviewed herein are consistent with C.162's conceptual underpinnings and reflect the universality and reasonableness of its provisions. Standing alone, however, medical surveillance cannot be viewed as an alternative to sound work practices, control technology, or environmental monitoring to reduce worker exposure.[40] The medical surveillance provisions discussed herein therefore must be viewed as but one small component of an overarching, cohesive administrative scheme for inspection, engineering controls, and enforcement of a host of occupational safety and health programs.

The nations used as examples in this paper span the gamut of economic levels, from developing to fully-industrialized. Yet, each recognizes the importance of good medical surveillance, as reflected also in international norms, within the purview of their respective national laws. These regulations are therefore likely to withstand judicial scrutiny and remain enforceable as widely accepted norms in these and other nations, for many years to come.

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APPENDIX I: INTERNATIONAL LABOUR CONFERENCE

Convention 162

CONVENTION CONCERNING SAFETY IN THE USE OF ASBESTOS

PART IV. SURVEILLANCE OF THE WORKING ENVIRONMENT AND WORKERS' HEALTH

Article 20

1. Where it is necessary for the protection of the health of workers, the employer shall measure the concentrations of airborne asbestos dust in workplaces, and shall monitor the exposure of workers to asbestos at intervals and using methods specified by the competent authority.

2. The records of the monitoring of the working environment and of the exposure of workers to asbestos shall be kept for a period prescribed by the competent authority.

3. The workers concerned, their representatives and the inspection services shall have access to these records.

4. The workers or their representatives shall have the right to request the monitoring of the working environment and to appeal to the competent authority concerning the results of the monitoring.

Article 21

1. Workers who are or have been exposed to asbestos shall be provided, in accordance with national law and practice, with such medical examinations as are necessary to supervise their health in relation to the occupational hazard, and to diagnose occupational diseases caused by exposure to asbestos.

2. The monitoring of workers' health in connection with the use of asbestos shall not result in any loss of earnings for them. It shall be free of charge and, as far as possible, shall take place during working hours.

3. Workers shall be informed in an adequate and appropriate manner of the results of their medical examinations and receive individual advice concerning their health in relation to their work.

4. When continued assignment to work involving exposure to asbestos is found to be medically inadvisable, every effort shall be made, consistent with national conditions and practice, to provide the workers concerned with other means of maintaining their income.

5. The competent authority shall develop a system of notification of occupational diseases caused by asbestos.

APPENDIX II: RECOMMENDATION 172
RECOMMENDATION CONCERNING SAFETY IN THE USE OF ASBESTOS
IV. SURVEILLANCE OF THE WORKING ENVIRONMENT AND WORKERS' HEALTH

29. In cases determined by the competent authority, the employer should make arrangements for systematic surveillance of the concentration of airborne asbestos dust in the workplace and of the duration and level of exposure of workers to asbestos and for the surveillance of the workers' health.

30. (1) The level of exposure of workers to asbestos should be measured or calculated in terms of time-weighted average concentrations for a specific reference period.

(2) The sampling and measurement of the concentration of airborne asbestos dust should be carried out by qualified personnel, using methods approved by the competent authority.

(3) The frequency and extent of sampling and measurement should be related to the level of risk, to changes in the work processes or other relevant circumstances.

(4) In evaluating the risk the competent authority should take into consideration the risk posed by all sizes of asbestos fibres.

31. (1) For the prevention of disease and functional impairment related to exposure to asbestos, all workers assigned to work involving exposure to asbestos should be provided, as appropriate, with –

(a) a pre-assignment medical examination;

(b) periodic medical examinations at appropriate intervals;

(c) other tests and investigations, in particular chest radiographs and lung function tests, which may be necessary to supervise their state of health in relation to the occupational hazard and to identify early indicators of disease caused by asbestos.

(2) The intervals between medical examinations should be determined by the competent authority, taking into account the level of exposure and the workers' state of health in relation to the occupational hazard.

(3) The competent authority should ensure that provision is made, in accordance with national law and practice, for appropriate medical examinations to continue to be available to workers after termination of an assigment involving exposure to asbestos.

(4) The examinations, tests and investigations provided for in subparagraphs (1) and (3) above should be carried out as far as possible in working hours and should entail no cost to the worker.

(5) Where the results of medical tests or investigations reveal clinical or preclinical effects, measures should be taken to prevent or reduce exposure of the workers concerned and to prevent further deterioration of their health.

(6) Results of medical examinations should be used to determine health status with regard to exposure to asbestos and should not be used to discriminate against the worker.

(7) The results of medical examinations should be used to help place the worker in a job which is compatible with the status of his health.

(8) Workers subject to supervision of their health should have–

(a) the right to confidentiality of personal and medical information;

(b) the right to full and detailed explanations of the purposes and results of the supervision;

(c) the right to refuse invasive medical procedures which infringe on their corporal integrity.

32. Workers should be informed in an adequate and appropriate manner, in accordance with national practice, of the results of the medical examinations and receive individual advice concerning their health in relation to their work.

33. When an occupational disease caused by asbestos has been detected by health surveillance, the competent authority should be notified in conformity with national law and practice.

34. When continued assignment to work involving exposure to asbestos is found to be medically inadvisable every effort should be made, consistent with national conditions and practice, to provide the workers concerned with other means of maintaining their income.

35. National laws or regulations should provide for the compensation of workers who contract a disease or develop a functional impairment related to occupational exposure to asbestos, in accordance with the Employment Injury Benefits Convention, 1964.

36. (1) The records of the monitoring of the working environment should be kept for a period of not less than 30 years.

(2) Records of the monitoring of exposure of workers as well as the sections of their medical files relevant to health hazards due to exposure to asbestos and chest radiographs should be kept for a period of not less than 30 years following termination of an assignment involving exposure to asbestos.

37. The workers concerned, their representatives and the inspection services should have access to the records of the monitoring of the working environment.

38. In the case of closure of an undertaking, or after termination of engagement of a worker, records and information kept in accordance with Paragraph 36 above should be deposited in accordance with the directions of the competent authority.

39. In accordance with the Tripartite Declaration of Principles concerning Multinational Enterprises and Social Policy, adopted by the Governing Body of the International Labour Office, a national or multinational enterprise with more than one establishment should be required to provide safety measures relating to the prevention and control of, and protection against, health hazards due to occupational exposure to asbestos, without discrimination, to the workers in all its establishments regardless of the place or country in which they are situated.

V. Information and education

40. The competent authority should take measures to promote the training and information of all persons concerned with respect to the prevention and control of, and protection against, health hazards due to occupational exposure to asbestos.

41. The competent authority, in consultation with the most representative organisations of employers and workers concerned, should draw up suitable educational guides for employers, workers and others.

COMPENSATING VICTIMS OF OCCUPATIONAL LUNG DISEASE: THE PHYSICIAN'S ROLE IN THE SYSTEM

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The legal remedies available to victims of occupational lung disease are chiefly of two types: claims for benefits under workers' compensation laws, and suits for damages under the laws of products liability. In workers' compensation law the claimant is required to prove that the employee's death or disability had been caused by his employment, and "disability" usually means that the worker has lost income because he is unable to do his regular job. Under the law of products liability, a supplier of toxic materials is required to warn of dangers involved in handling the materials; the failure to give adequate warning renders the material *unreasonably dangerous* and its supplier liable in damages to the unwarned victim harmed by the material. In both kinds of proceedings, disputed questions of diagnosis, etiology, causation and disability are decided by litigation. These issues involve very complex scientific testimony and a costly battle of experts.[1] The role of the physician as medicolegal consultant and expert witness is: (1) to describe and diagnose all significant pathology; (2) to prove or disprove a causal relationship between the significant pathology and impairment or death; (3) to identify and explain the etiology of the significant pathology; and (4) to evaluate impairment and disability.

THE PHYSICIAN'S ROLE AS MEDICOLEGAL CONSULTANT

Whether clinician or pathologist, the medicolegal consultant must study and evaluate the available evidence of clinical history, occupational history, environmental history, and the history of smoking and other social habits. He should make known his information requirements to the consulting attorney, whose duty it is to use his access to legal processes for gathering facts in order to furnish to the medical consultant all needed data. In his study of the clinical history, the medical consultant should include chest X-ray films, electrocardiographic records, tests of pulmonary function and other relevant laboratory data. If he considers his knowledge of these matters wanting, the medical consultant should candidly acknowledge his limitations to the referring attorney and request additional consultations with appropriate medical specialists.

In performing his investigation, the medical consultant should acquire familiarity with the reported studies which correlate pathologic findings, radiologic appearances and measured pulmonary function. In death cases, the tendency of pathologists to sample the "worst" areas they see at autopsy may mislead the consulting pathologist to a conclusion that the pathology was more severe than was actually the case; but if there are other physiologic data available, this sampling error can often be identified.[1] Because the histopathologic evaluation may be a more or a less sensitive detector for certain diseases than either pulmonary function or radiology, the need for review of all information, clinical and pathologic, is underscored.[1]

The medical consultant should also become informed about the prevalences and etiologic associations of diseases established by epidemiology. In his study of the occupational and environmental history, the medical consultant should identify and comprehend the importance of relevant exposures to toxic substance pollution. For such knowledge, consultation with a chemist, toxicologist or industrial hygenist may be required; and the physician should make the need known to the referring attorney.

Using *all* of the collected information, the consulting physician prepares his opinions as to diagnosis, etiology, causation and disability. In the litigation setting, it is especially important that in expressing diagnoses the medical consultant employ recognized disease nomenclature and standard terminology. As legal counsel, I have frequently witnessed occasions where medical experts ignore or reject the published diagnostic standards and instead employ peculiar nomenclatures and diagnostic criteria in a regrettable litigation tactic calculated to confuse.

In formulating his opinions, the consulting physician must also take into account the *legal* criteria as provided to him by the referring attorney. It is important to realize that the legal criteria and the medical criteria may conflict. The definition of *pneumoconiosis* illustrates the conflict. Whereas medicine's diagnosis requires lung tissue reaction to inhaled dust, Federal black lung law does not; the latter applies the term *pneumoconiosis* to any and all chronic respiratory impairments etiologically related to inhaled coal mine dust.[1]

The medical consultant must also comprehend the applicable legal standard of causation, and his opinion must conform to it. When death or disability is due to multiple diseases, of which one creates liability, the question is perplexing. Take, for example, the extremely dyspneic, cigarette smoking insulator whose diagnoses included bronchogenic carcinoma, centrilobular emphysema, asbestosis and severe coronary artery disease with congestive heart failure. Should the medical consultant rank the conditions according to their order of contributing importance; and even quantify by informed estimate the contribution to death or disability made by each? When *is* the contribution of the single, *compensable* disease

large enough to permit the finding that it had *caused* the death or disability? Depending on the type of legal proceeding and the jurisdiction involved, the legal standard of causation which will be applied for determining whether the contribution by occupational disease had been sufficient, can vary from *any* contribution, to *significant* or *substantial* contribution, to *primary* cause, to requiring that the occupational disease *in and of itself* be the cause of death or disability.[1]

After completing all examinations, all testings, and the study of all records and materials, the medical consultant is then able to compose his report. The report should identify the records and materials that had been studied or considered. Findings should be described with measured preciseness and in detail. The opinions expressed may be based on any source, including such hearsay sources as hospital records, reports of other physicians, statements elicited from the disease's victim, and acknowledged scientific treatises; *provided* that the source is inherently reliable and of the kind customarily relied upon by experts in forming their opinions.[1] The report might cite by reference appropriate authorities to support the conclusions reached.

The ultimate conclusions as to diagnosis, etiology, causation or disability should be reached by standard methodological principles[2] and held with "reasonable medical certainty," and reasonable medical certainty *must* include *logical* deduction from the data available and a comparison with the known literature on the subject.[1] The bases for all opinions and conclusions must be stated in order to demonstrate that they reflect reasoned medical judgment. "An opinion without articulated bases...is...not very persuasive".[3]

The report is not confidential and is available to all parties to the proceeding. It may become admitted into evidence and, unsupplemented by oral testimony, constitute the plenary statement of the physician. If the author of the report does give oral testimony at deposition or hearing, any ambiguities or errors in the report will be used to discredit its author's opinions. Therefore, special attention must be assigned to preparation of the report. Requests from the referring attorney for amplification are common and should not be regarded as slighting or offensive. The importance of completeness, accuracy, and unequivocality in a report intended for use in a legal proceeding is absolutely essential.

THE PHYSICIAN'S ROLE AS EXPERT WITNESS

In workers' compensation and in products liability cases, much of the scientific evidence is greatly beyond the ken of most adjudicators. Only by the testimony of expert witnesses which explains the case can a litigant successfully present its contention with respect to the issues of diagnosis, etiology, causation or disability. The "battle of experts" has in consequence become a standard part of occupational lung disease litigation.

The testimony of the medical consultant, as expert witness, will be presented by oral testimony given under oath. The opposing party will have a full right to cross-examine the expert witness as to all matters covered in direct examination. The setting for testimony may be the court room in the presence of judge and jury; or it may be the physician's own office by way of stenographic or videotape deposition which is later read or shown to the adjudicator in the court room or at a hearing.

Because a decision in a case is often reached by adopting a particular expert's opinion, it is important that the trier of fact be informed as to the professional qualifications of the expert. According to Belli, a famous trial lawyer, one must impress the jury with and by the witness' credentials. "The more experience the expert has and the more widely recognized he or she is as an authority in the field, the more impressed the members of this jury will be; they will then accord such testimony more weight."[1] Therefore, the expert witness should be prepared to provide, without modesty or exaggeration, an accurate and complete description of his professional qualifications.

In either his preparation for trial or during the presentation of his testimony at trial, the expert witness may desire to review the information upon which his opinions had been based. He is permitted to refer to any matters, including X-ray films and pathologic materials, or even his own report, in order to refresh his memory. However, once referenced, the information becomes subject to the cross-examiner's full right to examine and use it. Occasionally, embarrassment occurs when inspection at trial of the expert's file results in disclosure of forgotten contents which the witness would have preferred to keep private.

References to learned treatises are often invoked in order to corroborate or to impeach the expert's attested opinions. The Federal Rules of Evidence provide: "To the extent called to the attention of an expert witness upon cross-examination or relied upon by him in direct examination, statements contained in published treatises, periodicals, or pamphlets on a subject of history, medicine or other science or art, established as a reliable authority by the testimony or admission of the witness, ...may be read into evidence...."[1]

Although the law requires the expert witness to declare that he holds his opinion with a "reasonable degree of medical certainty," this traditional legal formulation may not harmonize with the new formulations of epidemiology. The point is well illustrated where lung cancer is seen in a smoking asbestos worker who had been exposed to other carcinogens. According to Enterline, an opinion about the tumor's etiology *cannot* be stated with *certainty*, because to attribute with *certainty* lung cancer to asbestos would falsely imply that the asbestos exposure somehow blocked the possible effects of all other cancer-causing agents; *but* an opinion *can* be expressed relatively as a mathematic probability for each carcinogenic agent to which the worker had been exposed.[1] At what point medicine's *probability* becomes equivalent to law's reasonable medical certainty is yet to be addressed by the courts. Until it is, the problem will certainly perplex the knowing and conscientious medical expert.

When his opinions are informed, honest and forthright, the physician, who has properly prepared, should not be apprehensive about performing as expert witness and giving oral testimony. Nor should he be timid in his criticism of other physicians when he knows that their opinions are *not* informed, honest or forthright.

The late C. L. Anderson, a pulmonologist at Western Pennsylvania Hospital in Pittsburgh who possessed wide experience as an expert witness, gave some advice which I will pass on: On cross-examination, do not be misled by hypotheticals; stick to what is known medically; be not persuaded by "what might be" or "what could be"; stay with "what is", avoid the fate of the unwary physician led by the cunning cross-examiner down the path to an improbable disease state.[1] Keeping in mind the specific medicolegal issues about which he has been consulted, the medical expert, in giving testimony, should avoid digression, remain relevant, and explicate his points comprehensibly. And be convincing! "However learned and honest the person may be, it must always be remembered that it is not just what the expert knows, it is also what the [referee judge or] jury understands and believes the expert knows."[1]

CONCLUSION

The outcome of occupational lung disease litigation is determined more by medical points than by legal points. The attorney who is an experienced and successful litigator of these cases will know generally the medicine of lung disease and be particularly up on the medical aspects of the case with which he is immediately involved. Because the role of the expert witness is so important to the result, the physician who would be medical consultant and expert witness should anticipate cross-examination by an informed attorney. For the physician who is himself informed about the subject of his testimony, being an expert witness should not create concern because the medical and scientific training of a physician gives him enormous advantage over an adversary trained in the law.

The physician who becomes a medicolegal consultant in a litigated case of occupational lung disease enters into a very topical, socially sensitive and intellectually stimulating professional activity.

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PRODUCT STEWARDSHIP OR BANS? ASBESTOS IN THE THIRD WORLD

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In the technological development of nations, it has been widely accepted that each country would do well to choose "appropriate technology" based on its resources, its people and their needs. Public health impacts of some technologies render them undesirable for Third World country development. Let us consider asbestos.

No one would urge that developing countries today should build plants to make asbestos thermal insulation. Asbestos has been replaced by wood pulp, fibrous glass, and other materials to make insulation products far less deadly than the asbestos insulations used in the past. Thermal insulation reinforced with asbestos is an example of *discredited technology* because of its severe, unavoidable hazards and the availability of safer alternatives. The most recent manufacture of this product I know of was in 1980; however, it may still be made by producers in Thailand and/or India.

Industry Theory: Controlled Use Exists and Is Becoming Universal

The international asbestos industry has claimed for decades that asbestos can be used safely and that it should be used in Third World development. Corrugated asbestos-cement roofing is used worldwide, and together with other asbestos-cement sheet and pipe products accounts for over 80 percent of asbestos use. Increased use of asbestos in developing countries has offset tremendous market losses in the industrial nations over the last 10 years. Quarterly publications of the Asbestos Institute in Quebec describe aggressive sales efforts in Asia, Africa, and Latin America.

The International Labor Office has published a "Code of Practice" enumerating very basic safeguards that should be used in work with asbestos.[1] Some countries have regulations that apply to industries where asbestos hazards exist. The issuance of control instruments as published documents, however, never has and never will assure that the "mandated" controls are in fact applied. The gulf between what is advertised as "controlled use of asbestos" and the reality of manufacturing and construction work with asbestos is greatest in the poor countries whose use of asbestos is on the rise.

Widespread Uncontrolled Use in Developing Countries

The chief of Brazil's environmental protection agency wrote in 1986 that the labor authorities in charge of worker protection did "poor work" and were "very ineffective."[2] As of 1986, this official wrote that, "we don't make any (power tools with exhaust ventilation) in Brazil, and it is difficult to import them."[3] It seems highly unlikely that portable saws with exhaust ventilation and dust capture are being used by construction workers handling asbestos-cement products in countries like Brazil. When that country's authorities began to inquire about health risks in asbestos manufacturing operations in 1980, the government people depended upon companies visited to provide and demonstrate the use of standard air monitoring equipment. As of 1986, the official workplace exposure limit for asbestos in Brazil was 4 fibers/cc, twenty times as high as the limit in the U.S.

Uncontrolled use of asbestos has been the norm in many countries, even in recent years. Mexican researchers found severe asbestosis in workers employed spraying asbestos; workers spraying asbestos were monitored as having exposures of 54 fibers/cc in 1982.[4] Investigations in India showed complete disregard for worker health by affiliates of U.S. and U.K. multinational corporations making asbestos products.[5,6] In one Indian plant, where I have been told asbestos-cement pipe was sawed without local exhaust ventilation, government hygienists measured exposures of 216-418 fibers/cc.[7]

If the asbestos industry is taking concerted action to implement "controlled" use of asbestos today, it represents a complete reversal of recent practices. In 1977, Canadian asbestos mining firms arranged to delete warning labelling about the cancer hazard of asbestos, opting instead to accept written releases of liability from a distributor in Japan.[8] Similarly, 1978 minutes of the Asbestos International Association reveal an international conspiracy to proceed as slowly as possible, country by country, using the weakest possible warning labels "in fear of a possible influence on sales."[8,9]

Given the historic lack of both industry product stewardship and controlled asbestos exposures, especially in the vulnerable developing countries, the operative question is: *Will* asbestos hazards be controlled? (not: *Can* asbestos hazards be controlled?) The burden is on the asbestos industry to demonstrate that it is practical to routinely use asbestos in a thoroughly controlled way in developing countries.

The record to date suggests that it is unreasonable to expect that asbestos hazards will be controlled in the developing countries. Industry spokesmen acknowledge that, even now, construction contractors in the U.S. sometimes use abrasive disc saws to cut asbestos-cement pipe—despite advice against the practice by the A-C Pipe Producers Association and the existence of applicable OSHA standards since 1972. Similar problems have been reported with the use of asbestos-cement sheet in U.S. construction work.[10]

How then can we expect Third World manufacturers of asbestos products and construction contractors to take on the cost of extraordinary control measures, when there typically isn't even pressure from industry or government authorities to do so? Where is the infrastructure of prevention (information, regulation, and compensation) in Third World countries? And why should developing countries submit to the likelihood of asbestos contamination and disease, when safer alternatives exist that will not warrant the unprecedented commitment of scarce public health resources?

Developing countries may also wish to consider another form of "pollution" that has frequently come along with the growth of an indigenous asbestos industry. This is the corruption of the fledgling professions of industrial medicine and hygiene, as pressures are brought to bear on health professionals in industry, government and academia to learn the "industry line" and downplay concerns about workplace and environmental exposure to asbestos. This impact on a vital sector of a society in development may pave the way for subsequent public health abuses by other industries. Again one must wonder, why should a developing country want to accept the externalized costs of a growing asbestos industry, given the alternatives available in 1988?

Asbestos Substitutes

In the 1980s, an increasing array of asbestos-free products has become commercially available. Asbestos-containing corrugated and flat cement sheeting, valve and pump packings, roofing felts, pipeline wrap, and vinyl flooring are no longer even made in the United States. In Europe, the Swiss Eternit Group (SEG) has agreed to eliminate asbestos in fiber-cement sheet products by 1990 in Germany and Switzerland, in favor of polyolefin fiber-cement sheet. SEG is experimenting with dozens of plant fibers and has already been able to replace asbestos with cellulose and wood fiber substitutes in Costa Rica and other Latin American countries.[11] The asbestos-free products carry warranties equal to those of the predecessor asbestos products. In Australia and Malaysia, James Hardie and its affiliates are making cement sheet products reinforced with wood pulp instead of asbestos.

This is progress indeed, when one considers that exposures from sawing asbestos-cement sheet without dust controls have been reported as over 100 fibers/cc.[12] It is also relevant that in many countries people catch water running off their roofs for drinking and cooking. EPA researchers have reported that "asbestos fiber concentrations over 500 million fibers per liter have been found in cistern drinking waters which use asbestos-cement roofing tiles to collect water."[13] It would be a relief if people had this burden of wood, coconut, or banana plant materials instead of asbestos in their drinking water.

The Role of the Canadian Government in Promoting Asbestos Use

When the U.S. Environmental Protection Agency proposed to ban asbestos, the Canadian government, representing both private and state-owned asbestos mines, applied considerable pressure to oppose the ban.[14] An article in the British magazine *The Economist* created a furor, for it suggested that Canada had become "a sort of merchant of death by unloading its asbestos on unsophisticated Third World clients who may not be aware of its dangers."[14,15] Canada's Energy, Mines and Resources Minister Marcel Masse was quoted as responding to the above article by writing, "(t)he risk can be managed anywhere. This includes the Third World, where governments are more aware of the risks and more capable of controlling them than your correspondent is willing to credit."[15] The *Toronto Star* went on to describe a $30 million campaign of federal and Quebec governments to "try to drag asbestos out of the doghouse."[15]

The Asbestos Institute, which is partly supported by Canadian taxpayers, also worries that EPA's proposed asbestos ban will impede the promotion of asbestos in countries which have little or no experience, let alone resources, in controlling industrial cancer threats. The Institute is a joint venture of the asbestos mining industry and the government, "to maximize the use of existing resources in a concerted effort to defend and promote the safe use of asbestos on a global scale." It claims to be "dedicated to promoting the proper use of asbestos."[16]

Canadian physician David Bates has called for the establishment of an independent commission ("recruited neither from industry nor from government employees") to monitor certain indicators of product stewardship in the export of Canadian asbestos and report annually to the public.[17] An appropriate topic for such an oversight panel would be the publication of lies like this by Asbestos Institute President Claude Forget: "In (Selikoff's) study of American insulation workers, asbestosis victims did not only inhale white asbestos as you state but were exposed to *mostly amosite asbestos*."[18] Canada's independent asbestos oversight panel, if it is ever set up, might also want to monitor the intimidation and villification of scientists at conferences where the hazards of asbestos are discussed. For example there is this by the Asbestos Institute Director of the Health and Environment Division, Jacques Dunnigan, at an asbestos conference in Mexico: "It is very hard for me to abstain from expressing my feeling that what we have just heard is standard, usual, ad nauseum repeated practice of some people at Mt. Sinai."[19]

Dr. Bates also called on the government of Canada to provide as much money for research into asbestos' health effects as is released for promotion of the industry. This balance, along with the creation of the oversight commission "would help to reassure average Canadians that they could not be accused of simply cynical exploitation of other people's ignorance," he concluded.[17] It *is* unworthy for the Canadian people to be represented by government officials who would rather sell ever more asbestos than plan for an asbestos-free future.

The Soviet Union's performance as a major exporter of asbestos fiber and technology is also worthy of scrutiny from a health standpoint. Reliable information on this would be most welcome, whether from the USSR, Canada, or other sources.

CONCLUSION

The eventual elimination of asbestos in favor of safer (and in

some cases essentially harmless) materials is of great public health importance. The continued lack of product stewardship by companies and countries mining asbestos, in the interim, constitutes a formidable health threat. It can only be hoped that this industry will see that its credibility and near-term survival depend upon worldwide implementation of unprecedented controls. Without this demonstration that asbestos *will* be used with stringent safeguards, the industry is sure to suffer rapid declines as social opposition mounts. Anyone who doubts the swiftness with which such events can move should note West Africa's revulsion at being used as a dumping ground for hazardous wastes from the U.S. and Europe.

My own experience with the asbestos industry leads to the conclusion that the only way to assure that asbestos will stop killing people needlessly is to ban it. This approach, which is being taken in Sweden and the United States, is even more attractive in developing countries where stringent regulation is not really a viable alternative to a ban.

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