INTER-ORGANIZATION CORRESPONDENCE

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TO All Administrative Physicians
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FROM David Joe Smith, M.D.
Assistant Medical Director

SUBJECT Reading X-Rays - Pneumoconiosis

PLAINTIFF'S EXHIBIT
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You will be reading and hearing much about the UICC/Cincinnati Classification of the Radiographic Appearances of Pneumoconiosis, a copy of which is attached. Reprints in quantity were available so we have decided to distribute them either for general information or for direct application as your particular situation requires.

David Joe Smith M.D.

DJS/dms
att.

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AUG 7 1970
VICE PRESIDENT
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HEALTH SERVICES
R. B. O'C.

SPECIAL REPORT

UICC/Cincinnati Classification of the Radiographic Appearances of Pneumoconioses

A Cooperative Study by the UICC Committee

H. Bohlig, M.D.
Chefarzt der Strahlenabteilung des Stadtischen Krankenhauses, Ludenscheid, Germany

L. J. Bristol, M.D.
Director, Silicosis Control Unit, Trudeau Institute, Inc., Medical Research Laboratories, Saranac Lake, New York

P. H. Cartier, M.D.
Medical Director, Thetford Industrial Clinic, Thetford Mines, Quebec, Canada

B. Felson, M.D., F.C.C.P.
Professor and Director, Department of Radiology, University of Cincinnati, Cincinnati, Ohio

J. C. Gilson, M.D., Chairman, UICC Working Group
Director, Medical Research Council, Pneumoconiosis Unit, Llandough Hospital, Penarth, U.K.

T. R. Grainger, M.D., F.C.C.P.
Medical Director, Canadian Johns Manville Company, Ltd., Asbestos, Quebec, Canada

G. Jacobson, M.D.
Professor and Chairman, Department of Radiology, University of Southern California, Los Angeles

R. Kiviluoto, M.D.
Chief Radiologist, Municipal Hospital and Docent of Radiology, Turku University, Turku, Finland

W. S. Lainhart, M.D.
Deputy Director, Division of Epidemiology and Special Services, Bureau of Occupational Safety and Health, Public Health Service, Cincinnati, Ohio

J. C. McDonald, M.D.
Professor of Epidemiology and Chairman, Department of Epidemiology and Health, McGill University, Montreal, Quebec, Canada

E. P. Pendergrass, M.D.
Emeritus Professor of Radiology, Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania

C. E. Rossiter
Statistician, Medical Research Council Pneumoconiosis Unit, Llandough Hospital, Penarth, U.K.; Assistant Professor of Medical Statistics, Department of Epidemiology and Health, McGill University, Montreal, Quebec, Canada

I. J. Selikoff, M.D., F.C.C.P.
Professor of Environmental Medicine, Mount Sinai School of Medicine, New York, New York

G. K. Sluis-Cremer, M.D.
Director, Miner's Medical Bureau, Johannesburg, South Africa

G. W. Wright, M.D.
Head, Medical Research Department, St. Luke's Hospital, Cleveland, Ohio

The Need for and the Development of a New Classification

The International Conferences on the Biological Effects of Asbestos held in 1964 and 1968 indicated renewed interest in the health hazards of asbestos dust and the need for further epidemiologic studies. This research is likely to be of greater value if valid comparisons can be made in different countries, where the methods of using asbestos differ and the exposures of the workers may be to only one type of asbestos fiber or to mixed asbestos and other dusts. A step towards improving comparability would be the existence of an internationally accepted classification of the radiographs. The International Union Against Cancer (UICC) Working Group on Asbestos and Cancer in 1964[1] recognized this need and recommended that "a scheme based if possible on an extension of the International Labour Organization (ILO) 1958 Classification[2] be developed." A number of schemes[3-8] have been suggested in the past, but none has come into general use or has been systematically tested for variations in interpretation between observers and by the same observer on repeated occasions.

To meet this need a group working under the auspices of the UICC Committee on Asbestos and Cancer in 1965 collected 125 films of men exposed to asbestos of different types and in different occupations from Canada, Finland, Germany, South Africa, United Kingdom and the United States. The films were read independently by all the members of the group, using a classification modified from one suggested by Bohlig[9] and Sluis-Cremer and Theron.[10] At about the same time, a group of radiologists working with the US Public Health Service, (USPHS) was also developing a classification for

the films of men working in the asbestos manufacturing industries in the United States. In March, 1967, Professor J. C. McDonald and his colleagues had an immediate need for a system of classifying several thousand films available from Asbestos and Thetford Mines in Quebec, where a survey of past and present asbestos workers was in progress.

The three groups met at the USPHS National Center for Urban and Industrial Health in Cincinnati for four days in October/November, 1967. They reviewed the results of the UICC reading trial, a pilot Canadian trial, and the experience of the USPHS group. A systematic examination of the radiographic features and the ways of recording them was made. Unanimous agreement was achieved on a proposed new scheme designated as the UICC. Cincinnati (U/C) classification which was an extension of the ILO 1958 classification. It was decided not to publish the proposal until tests had been made of its practicability and a study of the inter- and intra-observer variation carried out. During the period November, 1967 to April, 1968, 12 readers from six countries classified 100 films of asbestos workers. Following this, the group met in London where it was decided that the classification was sufficiently promising to be published together with the evidence about its practicability and observer variation. This report describes the proposed classification and comments on the results of the reading trials.

Aims of the Classification

1. To provide a scheme for the systematic recording of the various radiographic appearances associated with exposure to asbestos and other dusts.
2. To provide a system in which the qualitatively different features of the film can be recorded separately and graded.
3. To provide a code that permits a brief description of the important radiographic features of the pneumoconioses.

The primary aim is, therefore, to assist in epidemiologic studies of workers exposed to asbestos and other dusts and to relate these findings to other information, such as lung function, clinical features, past dust exposure, and studies of morbidity and mortality. At this time there is no attempt to establish a separate system of grading asbestosis. The radiographic appearances may vary with different types of asbestos exposure as well as with age and other factors. As the classification incorporates all the major features of the ILO 1958 scheme, together with the additional features seen in asbestosis, it is likely that the new proposals will prove adequate for the classification of all types of pneumoconiosis. However, further tests are needed to establish this.

Principles of the Classification

1. As far as possible it is purely descriptive of radiographic appearances and does not use interpretive words such as "fibrosis" or "infection" which already have definitions in terms of pathology.
2. It describes the natural history of the changes produced by asbestos and other dusts as far as is known, but it avoids the use of terms such as "early stages," "progressive," or "final."
3. It provides a system of recording semiquantitatively (with the help of verbal descriptions and standard films) features of the film which can be separately assessed with a reasonable degree of certainty.
4. It provides a means of describing the appearances seen in workers known to have been exposed to asbestos dust as well as other dusts.

The principles are, therefore, similar to those used in the ILO 1950 and 1958 schemes, but differ importantly from schemes which were primarily systems of grading the extent and severity of an assumed underlying pathology.

General Description of the Classification

The ILO 1958 scheme divided the opacities in the lung fields (lung parenchyma) into "small" and "large." The U/C scheme retains this main subdivision, but further divides the small opacities into "rounded" and "irregular," and the large opacities into "well defined" and "ill defined." The ILO scheme recorded pleural changes with a symbol "pl." The U/C scheme brings the pleural changes into the main classification, with a subdivision into "calcified" and "noncalcified."* It also records the presence of a poorly defined cardiac outline or diaphragm or both within the main scheme, but retains the symbols "co" (abnormal cardiac shape) and "cp" (suspect cor pulmonale) as defined in the ILO, 1958 scheme and its later modification by the USPHS.[1] Table 1 shows how the ILO 1958 classification and the U/C 1968 scheme fit together.

Provision has been made for the separate recording of three features for each variable:

1. *Type*. For example, small or large, rounded or irregular, calcified, etc.
2. *Profusion*. By this is meant the number of opacities (rounded or irregular) per unit area—eg. per zone (Table 1). The word "profusion" is used in preference to density because this latter word is also used radiologically to describe the radiopacity of a shadow. The profusion is graded on a basic 4-point scale, 0, 1, 2, 3, with a means of increasing this to a 12-point scale when greater precision is required (Table 1).
3. *Extent*. The area (number of zones) of the lung field affected or length, as in the case of cardiac border involvement. This also provides information about the site of abnormality, which may later be of value.

In the ILO 1958 scheme, category 1 of small opacities was defined in terms of the number of rib spaces involved—a measure of extent. Categories 2 and 3 included factors both of extent and of profusion. One of the criticisms of the ILO 1958 scheme is that it failed to provide for the classification of a film with definite but

* The use of the word "calcified" is at variance with the general principle of not using interpretive words, but was accepted because of its wide use in radiology.

Table 1—*Comparison of ILO 1958 and UICC/Cincinnati 1968 Classifications*

		ILO 1958	UICC/CINCINNATI 1968
	No pneumoconiosis	0	0/- 0/0 0/1 (rounded or irregular)
	Suspect pneumoconiosis	Z	
Small Opacities	Rounded		
	Profusion	1	1/0 1/1 1/2
		2	2/1 2/2 2/3
		3	3/2 3/3 3/4
	Type	p m n	p q r
	Extent	—	Lung zones, 1-3 on each side
	Irregular		
	Profusion	—	1/0 1/1 1/2
			2/1 2/2 2/3
			3/2 3/3 3/4
	Type	L	s t u
	Extent	—	Lung zones, 1-3 on each side
Large Opacities	Size	A B C	A B C
	Type	—	wd (well defined) id (ill defined)
Other Features	Pleural thickening	pl	
	Costophrenic angle		Right Left (lower limit standard film)
	Other—type		Diffuse Plaques (uncalcified)
	extent		1 2 3
	Ill defined diaphragm	—	
	Site		Right Left (lower limit standard film)
	Ill defined cardiac outline	—	
	Extent		1 2 3
	Pleural calcification	pl	
	Site		Diaphragm Walls Other sites
	Extent		1 2 3

Additional Symbols Used in Both Classifications (see text for definitions)

Obligatory in U/C and optional in ILO: ca co cp es od tba

Optional in both U/C and ILO: ax bu cn cv di em hi ho k px rl th

Notes

Types (sizes) of small opacities	The letters 'q' and 'r' are used in the U/C classification instead of 'm' and 'n' to reduce errors of transcription. There are no changes of definition.
12 point scale for small opacities	To use this, the film is classified in the usual way by comparison with the standard films and "if during the process a neighboring category is considered as a serious alternative, record this after the formal category". Thus a subcategory 2/1 is a Category 2 but Category 1 was considered as a serious alternative.

very sparse rounded opacities seen in more than two rib spaces. This criticism is met in the U/C scheme.

The classification recognizes the existence of a continuum of change from complete normality to the most advanced category or grade in the recorded features. For example, with regard to small opacities a film may be correctly classified as a category 0 if there are no opacities seen or if it is thought to show a few which are not sufficiently definite or numerous to reach the definition of category 1. No sudden step from normality to abnormality is implied at the 0-1 boundary.

Much thought was given to the advantages and disadvantages of a separate classification for asbestosis. This suggestion was unanimously rejected for two reasons:

1. Workers exposed to asbestos dust frequently have also been exposed to other types of dust, either in or outside the asbestos industry. Therefore, the radiographic signs of another type of pneumoconiosis, or even combined types, may be encountered among asbestos workers.

2. The ILO 1958 scheme and its USPHS modification have received wide international use. This was a strong argument for attempting to develop an extension of that scheme to cover asbestosis rather than develop a new classification.

Details of the Classification

Table 2 is a summary of the classification in a form convenient for reference while reading radiographs.

Small Opacities

Small Rounded Opacities. These are classified as in the ILO 1958 scheme modified by the USPHS, with some further alteration of the verbal definitions.

(a) *Type.* The nodules are classified according to the approximate diameter of the predominant opacities.

p = rounded opacities up to about 1.5 mm diameter.

q = rounded opacities exceeding about 1.5 mm and up to about 3 mm diameter.

Table 2—*UICC/Cincinnati Classification of Radiographic Appearances of Pneumoconioses*

		Codes	Definitions
Small Opacities	Rounded Profusion		The category of profusion is based on assessment of the concentration of opacities in the affected zones. The standard films define the mid categories.
		0/- 0/0 0/1	Category 0—small rounded opacities absent or less profuse than in category 1.
		1/0 1/1 1/2	Category 1—small rounded opacities definitely present but relative few in number.
		2/1 2/2 2/3	Category 2—small rounded opacities numerous. The normal lung markings are usually still visible.
		3/2 3/3 3/4	Category 3—small rounded opacities very numerous. The normal lung markings are partly or totally obscured.
	Type	p q r	The nodules are classified according to the approximate diameter of the predominant opacities
			p—rounded opacities up to about 1.5mm diameter.
			q—rounded opacities exceeding about 1.5mm and up to about 3mm diameter.
			r—rounded opacities exceeding about 3mm and up to about 10mm diameter
	Extent	Lung zones	The zones in which the opacities are seen are recorded. Each lung is divided into thirds—upper, middle, lower zones. Thus a maximum of 6 zones can be affected.
	Irregular Profusion		The category of profusion is based on assessment of the concentration of opacities in the affected zones. The standard films define the mid categories.
		0/- 0/0 0/1	Category 0—small irregular opacities absent or less profuse than in category 1.
		1/0 1/1 1/2	Category 1—small irregular opacities definitely present but relatively few in number The normal lung markings are usually visible.
		2/1 2/2 2/3	Category 2—small irregular opacities numerous. The normal lung markings are usually partly obscured.
		3/2 3/3 3/4	Category 3—small irregular opacities very numerous. The normal lung markings are usually totally obscured.
	Type	s t u	As the opacities are irregular, the dimensions used for rounded opacities cannot be used, but they can be roughly divided into three types.
			s—fine irregular or linear opacities.
			t—medium irregular opacities.
			u—coarse (blotchy) irregular opacities.
	Extent	Lung zones	The zones in which the opacities are seen are recorded. Each lung is divided into thirds—upper, middle, lower zones—as for rounded opacities.
Large Opacities	Size	A B C	Category A—an opacity with greatest diameter between 1cm and 5cm, or several such opacities the sum of whose greatest diameters does not exceed 5cm.
			Category B—one or more opacities larger or more numerous than those in category A, whose combined area does not exceed one third of the area of the right lung.
			Category C—one or more large opacities whose combined area exceeds one third of the area of the right lung.
	Type	wd id	As well as the letter 'A', 'B' or 'C', the abbreviation 'wd' or 'id' should be used to indicate whether the opacities are well defined or ill defined.
Other Features	Pleural thickening Costophrenic angle	Right Left	Obliteration of the costophrenic angle is recorded separately from thickening over other sites A lower limit standard film is provided.
	Other sites	1 2 3	Grade 0—not present or less than grade 1.
			Grade 1—up to 5mm thick and not exceeding one half of the projection of one lateral chest wall. A lower limit standard film is provided.
			Grade 2—more than 5mm thick and up to one half of the projection of one lateral chest wall *or* up to 5mm thick and exceeding one half of the projection of one lateral chest wall
			Grade 3—more than 5mm thick and extending more than one half of the projection of one lateral chest wall.
	Diaphragm Ill defined	Right Left	The lower limit is one third of the affected hemidiaphragm. A lower limit standard film is provided.
	Cardiac outline Ill defined (shagginess)	1 2 3	Grade 0—up to one third of the length of the left cardiac border or equivalent.
			Grade 1—above one third and up to two thirds of the length of the left cardiac border or equivalent.
			Grade 2—above two thirds and up to the whole length of the left cardiac border or equivalent
			Grade 3—more than the whole length of the left cardiac border or equivalent.
	Pleural calcification Diaphragm Walls Other sites	1 2 3	Grade 0—no pleural calcification seen.
			Grade 1—one or more areas of pleural calcification, the sum of whose greatest diameters does not exceed 2cm.
			Grade 2—one or more areas of pleural calcification, the sum of whose greatest diameters exceeds 2cm but does not exceed 10cm.
			Grade 3—one or more areas of pleural calcification, the sum of whose greatest diameters exceeds 10cm

Other Symbols

Obligatory

- ca —suspect cancer of lung or pleura
- co —a normality of cardiac size or shape
- cp —suspect cor pulmonale
- es —eggshell calcification of hilar or mediastinal lymph nodes
- tba—opacities suggestive of active clinically significant tuberculosis
- od —other significant disease This includes disease not related to dust exposure, e g. surgical or traumatic damage to chest walls, bronchiectasis, etc

Optional

- ax —coalescence of small rounded pneumoconiotic opacities
- bu —bullae.
- en —calcification in small parenchymal opacities
- cv —cavity
- di —marked distortion of the intra-thoracic organs
- em—marked emphysema
- hi —marked enlargement of hilar shadows
- ho —honeycomb lung
- k —Kerley (septal) lines.
- px —pneumothorax.
- rl —pneumoconiosis modified by rheumatoid process
- tb —inactive tuberculosis

r = rounded opacities exceeding about 3 mm diameter up to about 10 mm diameter.

(b) *Profusion.* The standard films define the midcategories.

Category 0—small rounded opacities absent or less profuse than in category 1.

Category 1—small rounded opacities definitely present but relatively few in number. The normal lung markings are usually visible.

Category 2—small rounded opacities numerous. The normal lung markings are usually still visible.

Category 3—small rounded opacities very numerous. The normal lung markings are partly or totally obscured.

The category of profusion is based not on extent, but only on the concentration of opacities in the affected zones.

(c) *Extent.* The specific zones in which the opacities are seen are recorded. Each lung field is divided into thirds—upper, middle, and lower zones. Thus, there can be a maximum of six zones affected.

(d) *Notes.*

(1) 'q' and 'r' are used in place of 'm' and 'n' of the ILO 1958 scheme because of phonetic and scriptory errors caused by using 'm' and 'n'. No change of definition is entailed.

(2) In category 1 small rounded opacities are commonly seen in the upper and middle zones, but may occur in any zones or in one lung only.

(3) There is evidence[m-u] that subdivision into finer grades than the four categories, 0, 1, 2, 3, is possible without the use of extra standard films, and conveys extra information for epidemiologic purposes. The instructions are to classify the film in the usual way into one of the four categories and if, during the process, a neighboring category is considered as a serious alternative, record this after the formal category. Thus category 2/1 is a film which is category 2, but category 1 was seriously considered as an alternative. The film which is without doubt a category 2, *ie*, a midcategory closely similar in profusion to the standard film, would be classified as 2/2. In films within category 0, a subdivision is also possible. Thus, category 0/1 is a film which is category 0, but category 1 was seriously considered. Category 0/0 is a normal film without small opacities. Occasionally films look exceptionally "normal" *ie*, there is exceptional clarity of the normal architecture. These "barndoor"* normal films are usually, though not exclusively, from young individuals. Provision for these is made by the category 0/-. Thus the formal four-point scale becomes a 12-point scale: 0/-, 0/0, 0/1, 1/0, 1/1, 1/2, 2/1, 2/2, 2/3, 3/2, 3/3, 3/4. In practice this elaborated scale takes no longer than the four-point system and it is easier for the reader, as his doubts about the borderline films are quickly recorded.

Small Irregular Opacities. This is the main new feature of the classification. The term is used to describe features which in other schemes have been called "linear," "reticular," "fibrotic," "network," "honeycomb." It includes films which would be classified as "L" in the ILO 1958 scheme, and also some, but not all, films formerly read as "Z." Small irregular opacities are of varying thickness, shape, and density, and often have a curved or linear appearance. They tend to obscure the normal lung architecture (vascular pattern), particularly when present in considerable profusion. Hence, obscuration of normal lung architecture is a feature of the higher categories of both small "rounded" and small "irregular" opacities.

(a) *Type.* As the opacities are irregular, the dimensions used for the rounded opacities cannot be applied, but to conform to the general scheme, the types may be roughly divided into three:

s = fine irregular or linear opacities.

t = medium irregular opacities.

u = coarse (blotchy) irregular opacities.

Assessment is made of the predominant type of small irregular opacity by comparison with the appropriate standard film.

(b) *Profusion.* The standard films define the midcategories.

Category 0—small irregular opacities absent or less profuse than in category 1.

Category 1—small irregular opacities definitely present, but relatively sparse. The normal lung markings are usually visible.

Category 2—small irregular opacities numerous. The normal lung markings are usually partly obscured.

Category 3—small irregular opacities very numerous. The normal lung markings are usually totally obscured.

The category of profusion is based not on extent, but only on the concentration of opacities in the affected zones.

(c) *Extent.* The specific zones in which the irregular opacities are seen are recorded. Each lung is divided into thirds—upper, middle, and lower zones, as for rounded opacities.

(d) *Notes*

(1) The types 's,' 't,' and 'u' are less well defined than the 'p,' 'q,' 'r' sequence of small rounded opacities. It is not known whether subdividing irregular opacities in this way will be useful, nor was it known when 'p,' 'm,' and 'n' were first suggested that pathologic and functional differences existed between the different types. Subsequent research has shown they are meaningful.[m-n]

(2) In category 1, small irregular opacities are more commonly seen in the lower zones, but may occur in any zones or in one lung only.

(3) The differentiation between "rounded" and "irregular" opacities is readily seen by comparing the standard films of each type, but films occur in which both types are seen. It is recommended that both "rounded" and "irregular" should be recorded if both types are clearly seen in the same film. However, further research is needed to show how well they can be differentiated.

(4) Experience in classifying films of those pneumoconioses in which the small opacities are predominantly rounded has revealed a small proportion which, though undoubtedly abnormal and probably the result of dust exposure, do not fit well into the ILO 1958 classification. The U/C classification provides a means of classifying these as they often fit well into the "small irregular opacities" group.

(5) Where there is a marked difference in profusion in different parts of the lungs, the zones predominantly affected are the ones over which averaging is made.

Large Opacities

The scheme used is that in the ILO 1958 classification, with the additional qualification of "well defined" (wd) and "ill defined" (id). The "well defined" large opacities are those covered by A, B, and C in the ILO 1958 system. The "ill defined" are those opacities in which the edge is very poorly differentiated from the surrounding lung. Large opacities of that type sometimes occur in advanced asbestosis, but are also seen in other types of pneumoconiosis. Thus U/C provides a more complete system of recording the features of large opacities.

Category A—an opacity having a diameter exceeding 1 cm and up to and including 5 cm, or several opacities each greater than 1 cm, the sum of whose greatest diameters does not exceed 5 cm.

* Oxford English Dictionary: "Barndoor" used jocularly as a target too large to be missed.

Category B—one or more opacities larger or more numerous than those in category A whose combined area does not exceed one-third of the right lung field.

Category C—one or more opacities whose combined area exceeds one-third of the right lung field.

Notes

(1) The abbreviation "wd" or "id" should be used to indicate whether the shadows are well or ill defined. Reference to the standard film will help to make the differentiation. Sometimes both types should be recorded.

(2) When recording large opacities the type and category of small opacities in the background should also be noted. If small opacities are not seen, a comment to this effect must be recorded.

Pleural Thickening

Pleural thickening is classified according to type (diffuse or plaques), site, and extent, but changes which might represent pleural thickening over the diaphragm and cardiac outline are recorded separately because there is insufficient evidence, especially in cases of asbestosis, to be certain whether the ill defined outline of the cardiac border (shaggy heart) or diaphragm or both results from pleural thickening or alteration of adjacent lung parenchyma.

Costophrenic Angle. Obliteration of the costrophrenic angle is recorded separately from thickening over other areas because it is so commonly seen in individuals with no history of dust exposure. A lower limit standard film is provided. No upper limit film is used. If the thickening extends further up the chest wall, then the film should be classified as costophrenic angle obliteration *and* pleural thickening, if this is up to grade 1 or more. Costophrenic angle obliteration is recorded as absent or present, right or left.

Note: Leafing (scalloping) of the diaphragm should not be recorded as costophrenic angle obliteration.

Chest Wall. Pleural thickening is recorded in four grades as follows:

Grade 0 = not present or less than grade 1.

Grade 1 = definite pleural thickening up to 5 mm thick which alone or combined with similar shadows does not exceed one-half of the projection of one lateral chest wall. The standard film is at the lower limit of grade 1.

Grade 2 = pleural thickening more than 5 mm thick and up to half of a lateral chest wall, *or* less than 5 mm thick if it extends more than the equivalent of one half of a lateral chest wall.

Grade 3 = pleural thickening more than 5 mm thick and extending more than the equivalent of one-half of a lateral chest wall.

Note: (1) Do not record the "companion" rib shadows that simulate pleural thickening.

(2) The sharpness of the outline of the pleural thickening varies greatly. In asbestos-exposed workers it may appear as a well defined band along the lateral chest wall (see Grade 1 standard film) or as a much more widespread shadow. The widespread and well defined forms are recorded together as "diffuse." Occasionally, localized areas of uncalcified pleural thickening—"pleural plaques"—are seen on the diaphragm or chest wall, and should be recorded as such. The diffuse and localized forms should be considered together when grading pleural thickening.

(3) Widespread pleural thickening on the anterior or posterior surfaces of the lung or chest wall may lead to veiling or obscuration of the lungs (ground glass appearance). It is graded on its maximum length. It is usually more than 5 mm thick.

Ill Defined Diaphragm

This is recorded as absent or present and right or left. The lower limit is one-third of the affected hemidiaphragm. A lower limit standard film is provided.

Note: A single adhesion, scalloping, hernia, eventration, calcification, plaque, and tumor are not included within the term "ill defined diaphragm."

Ill Defined Cardiac Outline

Only the length of the cardiac border affected is used for grading. The degree of poorness of definition is not separately recorded. Four grades are used. Regardless of which side is affected, the grading is based on its length in relation to the length of the left heart border.

Grade 0 = up to one-third of the length of the left cardiac border or equivalent.

Grade 1 = between one-third and two-thirds of the length of the left cardiac border or equivalent.

Grade 2 = between two-thirds and the entire length of the left cardiac border or equivalent.

Grade 3 = more than the length of the left cardiac border or equivalent.

Notes:

(1) Grade 1 is set fairly high so only the more definitely abnormal films will be graded 1 or above.

(2) The sharpness of the cardiac border is affected by heart movement and hence the exposure time of the radiograph. If heart movement is thought to be the only cause for the irregular cardiac border, do not record it.

(3) Cardiac fat pads are not included in the grading.

(4) In asbestos-exposed workers the earliest change in the radiograph may be an ill defined cardiac outline.

Pleural Calcification

This feature is recorded separately from pleural thickening, the site noted, and whether the calcification is uni- or bilateral. It is also graded with the help of standard films.

Grade 0 = no pleural calcification.

Grade 1 = an area of calcified pleura with greatest diameter not exceeding 2 cm, or a number of such areas, the sum of whose greatest diameters does not exceed 2 cm in length.

Grade 2 = an area of calcified pleura with greatest diameter exceeding 2 cm and not exceeding 10 cm, or a number of such areas, the sum of whose greatest diameters exceeds 2 cm but not more than 10 cm.

Grade 3 = an area of calcified pleura with greatest diameter exceeding 10 cm or a number of such areas whose sum of greatest diameters exceeds 10 cm.

Note: Uni- or bilaterality is recorded because calcification due to mineral dusts, including asbestos, is often bilateral whereas that due to other causes, such as infection or trauma, is more frequently unilateral.

Additional Symbols

Additional symbols are used as in the ILO 1958 scheme to record features which are not in the main classification. If all symbols are optional the recording is usually incomplete. Two groups—obligatory and optional—are therefore recommended.

Obligatory Symbols

ca – suspect cancer of lung or pleura.

co – abnormality of cardiac outline in size and shape, indicating cardiac disease.

cp – suspect cor pulmonale.

es – eggshell calcification of hilar or mediastinal lymph nodes.

od – other significant disease. This includes disease not related to dust exposure, eg, surgical or traumatic damage to chest walls, bronchiectasis, etc.

tba – active, clinically significant tuberculosis (excludes calcified primary complex).

Optional Symbols

ax — suspect coalescence of small rounded pneumoconiotic opacities.
bu — bullae.
cn — calcification in small parenchymal opacities.
cv — cavity.
di — marked distortion of the intrathoracic organs by pneumoconiosis.
em — marked emphysema.
hi — marked enlargement of hilar shadows.
ho — honeycombing of the lung.
k — Kerley (septal) lines.
px — pneumothorax.
rl — pneumoconiosis modified by rheumatoid process.
tb — inactive tuberculosis.

General Instructions

When deciding whether a film is to be classified within the scheme the following recommendations are made:

(1) Decide if there are no changes or if *any* of the changes seen in the pleura or the parenchyma sufficiently resemble the pattern of any of the pneumoconioses to be recorded. If so, proceed with the classification.

(2) If it is probable that *all* the changes seen are the result of some etiology other than pneumoconiosis, do not classify but record opinion using appropriate symbols and comments.

(3) If changes might be due to pneumoconiosis, classify features, but make a note that other etiology is possible.

In the U C scheme, unlike the ILO scheme, no provision is made for doubtful pneumoconiosis. This omission is intentional, as the scheme is intended principally for epidemiologic studies where a "suspect" group contributes little to the information. The provision of a 12-point scale for both "small rounded" and "small irregular" opacities provides a method of classifying radiographs showing fewer small opacities than in category 1.

In epidemiologic studies failure to record all readings can be an important source of loss of information. To reduce this to a minimum the recording sheet (Fig. 1) is so designed that at least one entry must be made between each pair of heavy lines. In Figure 1, ten sketches of the roentgen appearance of lesions in pneumoconiosis are given, together with their corresponding readings.

Results of Testing the Classification

(a) *Practicability*

The considerable increase in the amount of information to be recorded from each film compared with the ILO 1958 scheme might have reduced the practicability of the U/C Classification. This did not prove to be the case. Six members of the group classified nearly 16,000 chest films of past and present asbestos miners and mill workers at Thetford Mines and Asbestos (Quebec, Canada). No serious difficulties were encountered with the classification. Despite the number of observations to be made for each film, each reader was able to classify 300-500 films a day. By using the reading sheets and clerks to record, omissions were reduced to 0.3 percent in 42,000 readings. The films were a representative sample of the population at risk and, therefore, contained a high proportion of normal films; but some abnormality, however slight, was recorded in substantial number. The classification was done using a set of provisional standards derived mainly, though not exclusively, from films available from the Quebec mines.

(b) *Reproducibility of readings by the same observer (intra-observer variation)*

The variation in reading by the same observer over a few days to three months was investigated during the classification of the 16,000 Canadian films. For each observer, approximately 600 films selected at random were fed back for a second reading without his knowledge. This gave a realistic trial of intra-observer variation under survey conditions, but the proportion of films in some of the subgroups was too small to test fully their reproducibility.

The variation in the repeatability between the different features was not large (78 percent to 93 percent); also the range between observers was not very large. It was also apparent that the variation between observers was uniform so that no one observer was consistently higher or lower in his repeatability when all the features were taken together. These results were thought to be well within the acceptable limits for a new classification on its first use in a large survey.

(c) *Agreement between different observers (inter-observer variation)*

After the meeting in Cincinnati, a further reading trial of 100 films read independently by 12 of the group was organized. The 100 films were chosen so as to include about 30 normal or nearly normal films. The films were from six countries and covered most of the range of features seen in asbestos-exposed workers. There were no films of coalminers or other types of pneumoconioses in which small opacities classifiable on the ILO 1958 scheme were the main feature. The 100,000 or so observations were tabulated for easy inspection and analysis. (This tabulation may also be obtained on request).

Figure 2 shows the prevalence for the 12 readers of minimal changes (category or grade 1 or more) for small rounded opacities, small irregular opacities, pleural thickening and calcification and ill defined diaphragm. Agreement in reading calcified pleural plaques was best, as would be expected. The readings of irregular small opacities showed widest variation. This variation results in part from the lack of previous experience in grading this type of opacity compared with small rounded opacities and may be expected to decrease with practice and the improved standard films.

Inspection of the readings for each feature showed that the instances where only one reader out of 12 reported a feature were not randomly distributed among the readers. This strongly suggests that particular readers were consistent in interpreting what they saw, but at a higher or lower level than was accepted by the majority. This is an encouraging observation because systematic differences between readers can be allowed

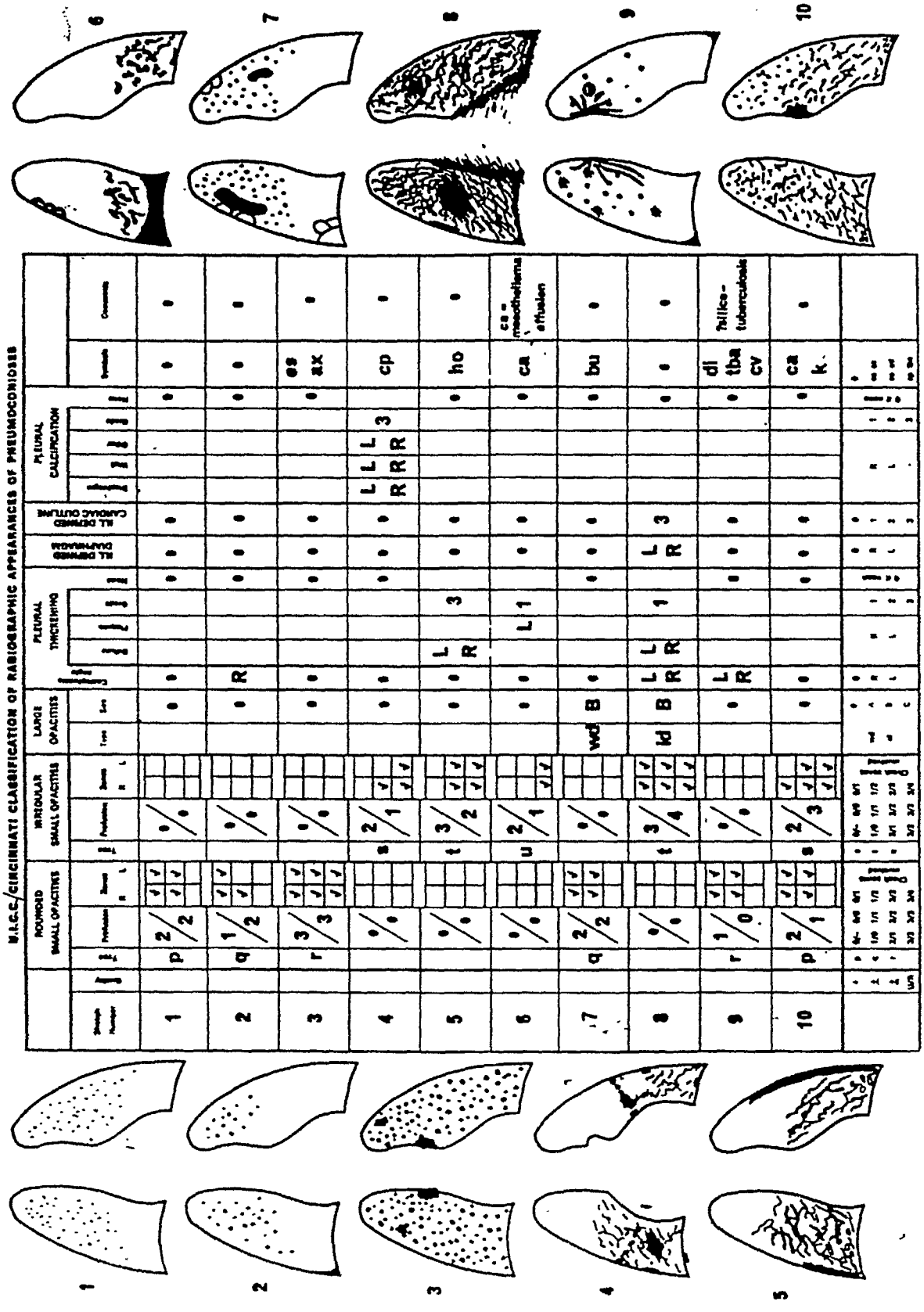
U.I.C.C./CINCINNATI CLASSIFICATION OF RADIOGRAPHIC APPEARANCES OF PNEUMOCONIOSIS
ROUNDED SMALL OPACITIES
IRREGULAR SMALL OPACITIES
LARGE OPACITIES
PLEURAL THICKENING
ILL DEFINED DIAPHRAGM
ILL DEFINED CARDIAC OUTLINE
PLEURAL CALCIFICATION
Symbols
Comments
1
2
3
4
5
6
7
8
9
10

Figure 1.

for in the analysis when several readers are used in a survey. It also suggests that better definition of the grades, and discussions between readers on a survey, will reduce bias between them while retaining the advantages of independent separate readings.[19] This was the first use of the classification by 12 readers from six countries with no opportunity for detailed mutual discussion on a pilot group of films, hence it was a stiff test.

In summary, the tests of practicability, intra- and inter-observer variation showed that the proposed classification had reached a stage where it was likely to be a useful tool in epidemiologic studies.

Radiographic Technique

In the reading trial on 100 films a comment was recorded on radiographic technique: good or acceptable (+), poor (+−), very poor (+−−), and unreadable (U/R).

Agreement about technique was worse than for any of the radiographic features in the classification, but standard films were not used for this assessment. The range "acceptable" to "very poor" was recorded by different observers on a quarter of the films so that criteria on what constitutes an acceptable film are not clearly established.

The majority of the films were taken with conventional methods and without grids. Proposals for achieving a higher proportion of good films by using grids and high KV techniques were made by three members of the group and are to be published.[20] All members of the group agreed that the average technical standard of routine and survey films was considerably below what could be achieved with existing equipment, but the films used in this trial were chosen from those readily available from many sources and so inevitably included a wide variation in technique. It was also agreed that there was a need for further trials to show the effect of changes of technique on readings.

Discussion

The U/C scheme is a logical extension of the ILO 1958 system of classifying the radiographs of pneumoconioses, to include features seen in asbestos-exposed workers. We believe that it will also be suitable for all types of pneumoconiosis, though further tests on many other forms of pneumoconiosis are necessary to prove this.

The important extensions are:

1. The replacement of the subdivision "L" of the 1958 scheme by categories of "small irregular opacities."
2. The subdivision "Z" is omitted.
3. Pleural changes, calcified and non-calcified, are bought into the main classification and graded.
4. The shaggy heart of asbestosis is recorded and graded separately from pleural changes, as "ill defined cardiac outline."
5. Similar changes in the diaphragms are recorded without grading.

It is the intention to provide standard films for the categories and types of small "rounded" and "irregular" opacities, large opacities, pleural thickening, pleural calcification, obliteration of the costophrenic angle (lower limit only), and the changes in cardiac and diaphragmatic outline. The method of producing the copies is still

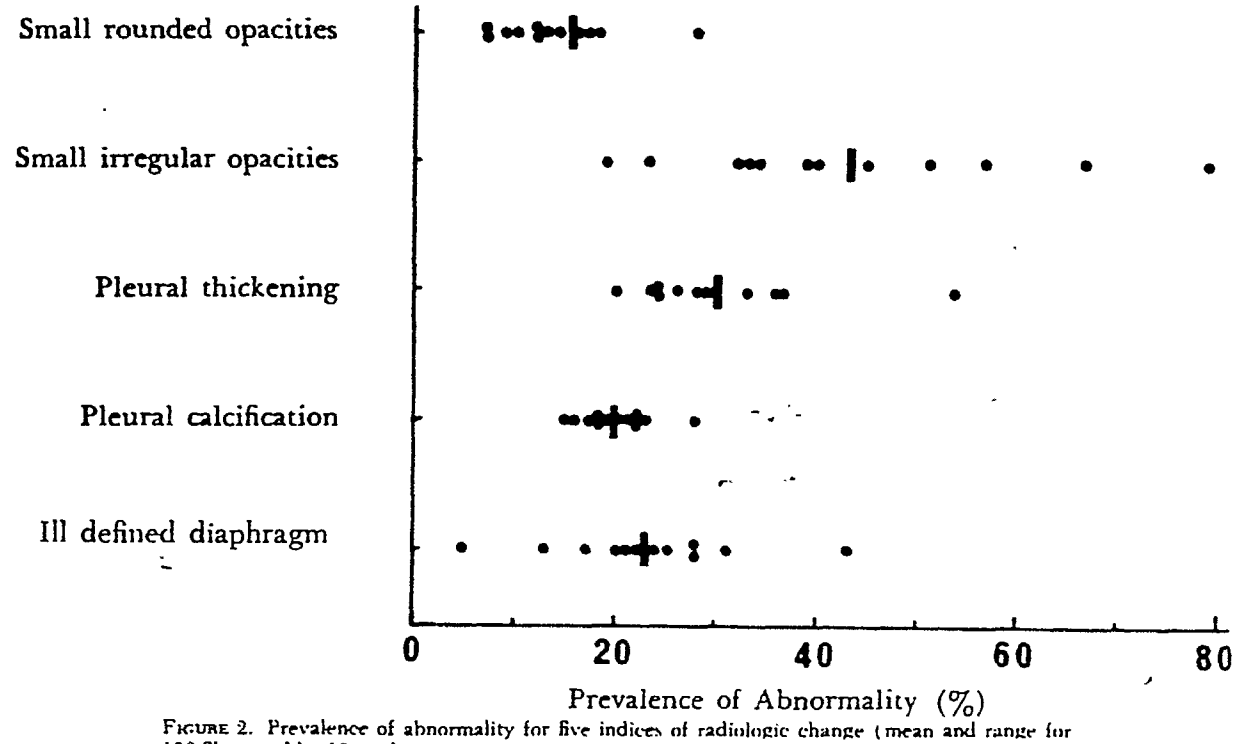

Figure 2. Prevalence of abnormality for five indices of radiologic change (mean and range for 100 films read by 12 readers).

under development, but in the interim, copies will be available* made by a better method than that used for the ILO 1958 standards.

At the Cincinnati meeting it was agreed that, in order to maintain as close correspondence as possible with the ILO schemes, the definition of categories of small rounded opacities should not be changed, though this might perpetuate the defect of the ILO 1958 scheme that *extent* and *profusion* of the opacities were combined in the definition. This has led to difficulties. There are films with a few but definite small round opacities in more than two rib spaces which by definition put the film beyond category 1, but the films clearly have far less profusion of opacities when compared with the category 2 standard. A meeting of experts at ILO in December, 1968[20] advised the separation of profusion and extent in the new revision of the ILO scheme, so this change has also been introduced into the U C proposals. Thus, the categories of small rounded and irregular opacities are based only on profusion (concentration of opacities in a defined area) using verbal definitions supported by standard films which are intended to be midcategory examples.

In recommending the use of the system of subcategories of small opacities developed and tested by the British National Coal Board's Pneumoconiosis Field Research Scheme, provision is made for the reader to use either the formal categories 0, 1, 2, and 3, or the full 12-point scale. This extended scale largely overcomes the need for a category Z ("suspect" pneumoconiosis) because the subcategories 0/1 and 1/0 provide two ranges on the continuum between a clearly normal film (0/0) and one read as midcategory 1 (1/1). The 12-point scale applies to both small rounded and irregular opacities. There is good evidence[13] that the reading levels in the formal categories are not disturbed by adopting the 12-point scheme, which does not require extra standard films and takes no longer to record, but does provide more information. The extent of the small opacities is recorded by noting the zones of the lung—upper, middle, and lower—in which the abnormality is present but without attempting to provide a grade for each zone. There was good agreement among readers on the zones affected. This innovation of mapping the distribution of lesions may be of assistance in distinguishing changes due to different dusts or from other causes.

However, separation of rounded from irregular opacities was less consistently achieved. The inconsistency here between readers shows the need for further trials on groups of films covering a wide range of the types of small opacities. Differences in reading levels and random errors can be reduced by closer attention to the standard films and prior discussions between readers, and probably by adopting the convention recommended of recording both rounded and irregular opacities if both types are definitely seen. However, further research is needed on this point. Independent readings still provide more information than attempting to get agreement between the observers on each film.[19]

All classifications are compromises between excessive complexity and over-simplification. The U/C scheme appears considerably more complex than the ILO 1958 system, but in practice it is no more difficult to use. Many of the features noted in the U/C scheme are in fact observed in the course of complete scrutiny of any film and the classification provides a simple means of recording these features semiquantitatively. In the Quebec study the readers reported very few films which could not be adequately described. The overall consistency of reading pattern when viewing the computer tabulations of the 100 films came as some surprise to the authors, especially as there had not been any extensive discussions on the pilot group of films among all the readers before the trial.

Improvements of the scheme are likely to come when more is known about the correlations between the separate features recorded and pathology, lung function, and type and intensity of past dust exposure. Information on this is already accumulating.[21]

Summary and Conclusions

The International Union Against Cancer (UICC) convened a Working Group on Asbestos and Cancer in 1964 which recommended that an international classification of the radiographic appearances of the chest films of asbestos-exposed workers be developed.

Three interested groups—the UICC Working Party, the U.S. Public Health Service Group of Radiologists, and a McGill University epidemiologic research group—met in Cincinnati in November, 1967. Agreement was achieved on a proposed new classification which is an extension of the International Labour Organization (ILO) 1958 scheme. Tests of the practicability and intra- and inter-observer variations made subsequently were sufficiently encouraging for the Group to recommend publication of the scheme at their next meeting in April 1968.

The principal extensions from the ILO 1958 scheme are:

1. Small opacities are subdivided into "rounded" (as in the ILO 1958 scheme) and "irregular." This new "irregular" group has four categories, 0-3, and describes verbally and with standard films the linear or irregular small opacities which are frequently seen in asbestosis and in some of the other pneumoconioses.
2. Large opacities, defined as in the ILO 1958 scheme, carry an extra comment on whether the outline of the shadow is well or ill-defined.
3. Pleural thickening, for which a single symbol was used in the ILO 1958 scheme, is brought into the main classification and divided into "calcified" and "noncalcified." A system of grading, with standard films, is provided. Costophrenic angle obliteration is separately recorded.
4. Ill-defined cardiac outline (shaggy heart) and diaphragmatic outline are also separately classified, using standard films.

*The standard sets are available from the American College of Radiology, 6900 Wisconsin Avenue, Chevy Chase, Maryland 20015 or from Dr. J. C. Gilson, MRC Pneumoconiosis Unit, Llandough Hospital, Penarth CF6 1XW, U.K.

5. The additional symbols used in the ILO scheme are divided into an obligatory and an optional group.

With a well-designed reading sheet, the classification was found easy to use by six readers from four countries in 16,000 radiographs from a survey of asbestos miners and mill workers in Quebec. The variation within the same observers was tested and found to be reasonably small. The variation between observers was tested in a study of 100 radiographs read by 12 readers from six countries. The results indicate that the classification should be satisfactory for many epidemiologic purposes. But it is clear that further improvement in definitions and in the standard films might be expected to improve the agreement between readers.

The classification is known as the UICC Cincinnati Classification of the Radiographic Appearances of Pneumoconioses. We believe it can be used to describe all the principal types of pneumoconiosis.

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Reprint requests: Dr. William Lainhart, 1014 Broadway, Cincinnati 45202.