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CONFERENCE

on

BIOLOGICAL EFFECTS OF ASBESTOS

Monday, October 19,
Tuesday, October 20, and
Wednesday, October 21, 1964

THE NEW YORK ACADEMY OF SCIENCES
SECTION OF BIOLOGICAL AND MEDICAL SCIENCES
2 East Sixty-third Street
New York, N. Y. 10021

The evening session on October 20
will be held at the Academy Building

ALL OTHER SESSIONS WILL BE HELD AT

The Waldorf-Astoria
Park Avenue at 50th Street
New York, N. Y.

This program will serve as a ticket of admission and is nontransferable.

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Preface of the Conference

In the four decades during which there has been acceptance of potential hazards associated with exposure to asbestos, solutions to the problems involved have been elusive.

Therapy of asbestosis remains largely a rearguard holding action once the diffuse interstitial fibrosis is established. Prophylactic measures are hampered by difficulties in early diagnosis, including the long latent period often noted between onset of exposure and clinical change.

Hard won data have been accumulating which indicate that neoplasia associated with asbestos exposure, especially those of the lung, are perhaps the most important industrial cancers at this time. This importance has been emphasized by the recent stimulating studies of South African and British investigators demonstrating the significant incidence of pleural and peritoneal tumors associated with asbestos exposure and by the knowledge that the various neoplasms might follow exposure of limited duration and intensity, inadequate to result in significant asbestosis.

There have been effective advances in dust control techniques, accomplished by diligent, ingenious and expensive engineering. However, application of these procedures has been hampered by the rapid growth of asbestos utilization, sometimes under circumstances in which exposure has been obscure or unrecognized. Moreover, community and indirect occupational exposure may occur; the scope and importance of such "asbestos air pollution" are at present uncertain but their potential significance has attracted attention.

The foregoing sober inventory provided the stimulus and background for this Conference. The Scientific Council of the Academy considered that the interdisciplinary nature of the problem, involving such distinct fields as experimental pathology, applied physiology, oncology, epidemiology, and industrial hygiene could best be served by a broad conference of investigators in the biological sciences and those in allied fields.

In October 1963 visits were made by Dr. Selikoff on behalf of the Academy to several European centers to investigate the feasibility and potential scope of such a conference. In particular, British studies were reviewed with Dr. J. C. Gilson, Director of the Medical Research Council Pneumoconiosis Research Unit. The cooperation of Dr. H. Heimann of the Division of Occupational Health of the United States Public Health Service facilitated a survey of current work in this country.

The Academy was fortunate in securing the advice of a Conference Committee which encompassed the major areas involved. Its members, themselves actively concerned with the problem, met January 6, 1964 in New York. The preliminary design of a meeting then formulated was refined during the succeeding months by the Committee with the assistance of active investigators in many parts of the world and by July, 1964 the Conference program was completed.

It is the hope of the Academy that this Conference will be a fertile one and will lead to decisive findings on this important problem.

Eunice Thomas Miner
Executive Director
The New York Academy of Sciences

July 17, 1964

ORGANIZING COMMITTEE

Irving J. Selikoff	Cochairman; The Mount Sinai Hospital, New York, N. Y.
Jacob Churg,	Cochairman; The Mount Sinai Hospital, New York, N. Y.
W. Clark Cooper	School of Public Health, University of California, Berkeley, Calif.
John C. Gilson	Pneumoconiosis Research Unit, Medical Research Council, Penarth, Glamorgan, Wales
E. Cuyler Hammond	American Cancer Society, New York, N. Y.
Thomas F. Mancuso	Graduate School of Public Health, University of Pittsburgh, Pittsburgh, Pa.
E. Lynn Schall	Occupational Health Program, New Jersey State Department of Health, Trenton, N. J.
William E. Smith	Health Research Institute, Fairleigh Dickinson University, Madison, N. J.

Conference Cochairmen:
I. J. Selikoff
and
J. Churg
The Mount Sinai Hospital
New York, N. Y.

PROGRAM

MONDAY, OCTOBER 19, 1964

Session Chairman: H. J. Magnuson
Institute of Industrial Health, University of Michigan
Ann Arbor, Mich.

9:00 A.M. –

Greetings from the Academy – Gabriel G. Nahas, Vice-Chairman, Section of Biological and Medical Sciences, The New York Academy of Sciences; College of Physicians and Surgeons, Columbia University, New York, N. Y.

Opening Remarks – I. J. Selikoff, The Mount Sinai Hospital, New York, N. Y.

ASBESTOS MATERIALS IN MODERN TECHNOLOGY

Session Cochairman: P. H. Riordon
Asbestos Corporation Limited
Thetford Mines, Quebec

"The Geology, Occurrences and Major Uses of Asbestos" – N. W. Hendry, Canadian Johns-Manville, Ltd., Asbestos, Quebec.

"Physical and Molecular Structure of Asbestos" – R. Gaze, The Cape Asbestos Company, Ltd. (Asbestosis Research Council), London, England.

LIVING TISSUE AND MINERAL MATTER: PROBLEMS OF PATHOGENESIS

Session Cochairman: I. Webster
Pneumoconiosis Research Unit
Johannesburg, South Africa

PROBLEMS OF IDENTIFICATION OF ASBESTOS IN HUMAN TISSUE: PANEL DISCUSSION

MODERATOR: P. Gross, Industrial Hygiene Foundation, Pittsburgh, Pa.

"Identification by Fluorescent Dye Staining and Electronically Activated Oxygen Ashing" – C. Berkley and J. Churg, The Mount Sinai Hospital, New York, N. Y.

"Identification of the Several Varieties of Asbestos Fibers in Human Lung Tissue" – A. Vorwald, Wayne State University College of Medicine, Detroit, Mich.

"Dust Content and Composition in Lungs with Asbestosis" – G. Nagelschmidt, Safety in Mines Research Establishment, Sheffield, England.

EXPERIMENTAL ASBESTOSIS
PANEL DISCUSSION

MODERATOR: J. C. Wagner, Medical Research Council Pneumoconiosis Research Unit, Glamorgan, Wales.

"Asbestos Dust Deposition and Retention in Animals" – J. C. Wagner and J. W. Skidmore, M.R.C. Pneumoconiosis Research Unit, Glamorgan, Wales.

"Experimental Asbestosis with Three Types of Fibers: Importance of Particle Size" – J. Mills and P. F. Holt, (Asbestosis Research Council), University of Reading, Reading, England.

"Electron Microscopic Studies of Asbestosis in Man and Animals" – J. M. G. Davies, (Asbestosis Research Council), University of Cambridge, Cambridge, England.

"Rheumatoid Factor in Serum of Individuals Exposed to Asbestos" – B. Pernis and E. C. Vigliani, University of Milan, Milan, Italy, and I. J. Selikoff, The Mount Sinai Hospital, New York, N. Y.

"Observations on the Pathogenesis of Asbestosis" – E. C. Vigliani and B. Pernis, University of Milan, Milan, Italy.

12:30 P.M. –
Luncheon

Session Chairman: J. H. Sterner
Eastman Kodak Company
Rochester, N. Y.

HUMAN EXPOSURE TO ASBESTOS:
ASBESTOSIS IN INDUSTRIAL POPULATIONS

Session Cochairman: J. C. Gilson
M.R.C. Pneumoconiosis Research Unit
Glamorgan, Wales

2:00 P.M. –

"Asbestosis in the United Kingdom" – J. C. McVittie, Ministry of Pensions and National Insurance, London, England.

"Asbestosis Among Insulation Workers in the United States" – I. J. Selikoff, J. Churg, and E. C. Hammond, The Mount Sinai Hospital, New York, N. Y.

"Mortality Rates Among Asbestos Products Workers in the United States" – P. Enterline, U. S. Public Health Service, Washington, D. C.

"Secular Changes in Asbestosis in an Asbestos Factory" – W. J. Smither, (Asbestosis Research Council), The Cape Asbestos Company, Ltd., London, England.

HUMAN EXPOSURE TO ASBESTOS: COMMUNITY STUDIES

Session Cochairman: J. Higginson
University of Kansas School of Medicine
Kansas City, Kan.

"Occupational and Nonoccupational Exposure to Asbestos" – W. C. Hueper, National Cancer Institute, Bethesda, Md.

"Prevalence of Asbestos Bodies in Autopsy Cases" – J. C. Thomson, University of CapeTown, CapeTown, South Africa.

"Asbestosis: Geographical and Environmental Studies in South Africa" – G. K. Sluis Cremer, Pneumoconiosis Bureau, Johannesburg, South Africa.

"Pleural Plaques and Asbestos: Further Observations on Endemic and other Nonoccupational Asbestosis" – R. Kiviluoto, Tampere Central Hospital, Tampere, Finland.

Session Chairman: J. [illegible] Wolfsie
United States Rubber Company
New York, N. Y.

Session Cochairman: L. Cralley
U.S.P.H.S. Occupational Health Research and Training Facility
Cincinnati, Ohio

8:00 P.M. –

"Inhalation of Fibrous Dusts" – V. Timbrell, M.R.C. Pneumoconiosis Research Unit, Glamorgan, Wales.

"Comparison of Impinger and Membrane Filter Techniques for Evaluating Air Samples in Asbestos Plants" – H. E. Ayer, Division of Occupational Health, U. S. Public Health Service, Washington, D. C.

"Developments in Dust Sampling and Counting Techniques in the Asbestos Industry" – S. Holmes, (Asbestosis Research Council), Turner Brothers Asbestos Company, Ltd. Rochdale, England.

"Dust Measurements and Monitoring in the Asbestos Industry" – C. G. Addingley, (Asbestosis Research Council), British Belting and Asbestos, Ltd., Yorkshire, England.

"Measurement of Airborn Asbestos Dust by Instruments Measuring Different Parameters" – S. A. Roach, London School of Hygiene and Topical Medicine, University of London, London, England.

Discussion opened by T. Hatch, University of Pittsburgh, Pittsburgh, Pa.

TUESDAY, OCTOBER 20, 1964

Session Chairman: Harriet L. Hardy
Massachusetts Institute of Technology
Cambridge, Mass.

DUST CONTROLS AND STANDARDS

9.00 A.M. –

"Present Threshold Limit Value in the U. S. A. for Asbestos Dust: A Critique" – E. L. Scholl, Occupational Health Program, New Jersey State Department of Health, Trenton, N. J.

"Economics of Dust Control" – D. W. Hills, (Asbestosis Research Council), Turner Brothers Asbestos Company, Ltd., Rochdale, England.

Session Cochairman: L. Silverman
School of Public Health, Harvard University
Boston, Mass.

PULMONARY ASBESTOSIS

"Radiological Classification of Pulmonary Asbestosis" – H. Bohlig, Municipal Hospital, Lüdensheid, Germany.

"Roentgenological Studies of Pleural Calcification in Asbestosis" – I. J. Selikoff, The Mount Sinai Hospital, New York, N. Y.

"Differential Diagnosis in the Pathology of Asbestosis" – J. Gough, Welsh National School of Medicine, Cardiff, Wales.

"Roentgenological-Pathological Correlations in Pulmonary Asbestosis in the United Kingdom and South Africa" – K. F. W. Hinson, Brompton Hospital and J. C. McVittie, Ministry of Pensions and National Insurance, London, England; G. K. Sluis Cremer and C. P. Theron, Pneumoconiosis Bureau, Johannesburg, South Africa.

Disscussion opened by P. Cartier, Thetford Industrial Clinic, Thetford Mines, Quebec, and I. Webster, Pneumoconiosis Research Unit, Johannesburg, South Africa.

PULMONARY FUNCTION IN ASBESTOSIS
PANEL DISCUSSION

MODERATOR: G. L. Leathart, University of Newcastle, Newcastle, England.

"Pulmonary Function in Asbestosis: Serial Tests in Long Term Prospective Study" – M. Bader, R. Bader and A. Tierstein, The Mount Sinai Hospital, New York, N. Y.

"Routine Lung Function Studies of 830 Employees in an Asbestos Processing Factory" – R. Hunt, (Asbestosis Research Council), British Belting and Asbestos, Ltd., Yorkshire, England.

"The Discriminant Value of Pulmonary Function Tests in Asbestosis" – M. L. Thomson, W. J. Smither, Anne-Marie Pelzer and M. Hills, London School of Hygiene and Tropical Medicine, University of London, London, and The Cape Asbestos Company, Barking, Essex, England.

Discussion opened by J. L. Whittenberger, School of Public Health, Harvard University Boston, Mass.

12:30 P.M. –

Luncheon

Session Chairman: W. C. Cooper
School of Public Health, University of California
Berkeley, Calif.

ASBESTOS AND NEOPLASIA: EXPERIMENTAL

Session Cochairman: Katherine R. Boucot
Woman's Medical College of Pennsylvania
Philadelphia, Pa.

2:00 P.M. –

"Studies of Carcinogenesis of Asbestos Fibers and Their Natural Oils" – J. S. Harington and F. J. C. Roe, Chester Beatty Research Institute, Royal Cancer Hospital, London, England.

"Preparation of Asbestos Fibers for Experimental Use" – M. S. Badollet, Health Research Institute, Fairleigh Dickinson University, Madison, N. J., and W. A. Gantt, Occupational Health Program, N. J. State Department of Health, Trenton, N. J.

"Tests for Carcinogenicity of Asbestos" – W. E. Smith and Llonas Miller, Health Research Institute, Fairleigh Dickinson University, Madison, N. J.

"Tests for Effect of Asbestos on Benzo (a) Pyrene Carcinogenesis

"Sequelae of Asbestos Dust Exposure" – J. C. Wagner, M.R.C. Pneumoconiosis Research Unit, Glamorgan, Wales.

"Changing Hazards of Asbestos Dust Expsure". – J. C. Gilson, M.R.C. Pneumoconoiosis Research Unit, Glamorgan, Wales.

"Multiple Factors in Relation to Neoplasia Among Asbestos Workers" – E. C. Hammond, The Mount Sinai Hospital, New York, N. Y.

PANEL DISCUSSION

Moderator: H. Heimann
Division of Occupational Health
U. S. Public Health Service
Washington, D. C.

The Section of Biological and Medical Sciences provides conferences for active workers in the special fields of biology and medicine.

This conference may be attended by interested Members of Academy, all physicians, research scientists, and science and medical students, as well as those invited to participate.

SECTION OF BIOLOGICAL AND MEDICAL SCIENCES

Preston L. Perlman
Chairman

Gabriel G. Nahas
Vice-Chairman

THE GEOLOGY, OCCURRENCES AND MAJOR USES OF ASBESTOS

SESSION 1, PAPER 1

by
N. W. Berdry
Canadian Johns-Manville, Ltd., Asbestos, Quebec

The mineral asbestos may be divided into two broad groups of fibrous silicates of varying composition, namely pyroxenes including chrysotile, and amphiboles including crocidolite, amosite, tremolite, actinolite and anthophyllite. The host rock for chrysotile is serpentine which is an alteration product of ultrabasic rock types such as dunite or peridotite or the alteration of magnesium rich limestone. Crocidolites and amosites occur in metamorphosed siliceous ferruginous sediments rich in iron and silica, termed banded ironstones. Tremolite and anthophyllite occur in crystalline schists, limestones and magnesium limestones. Concentrations of these minerals are found where structural deformation of the host rocks has taken place.

Total annual world production of asbestos exceeds 3 million tons, valued at approximately 200 million dollars. In broad terminology asbestos occurrences are present in most countries of the world. However, approximately 85% of the most important commercial varieties, chrysotile, crocidolite and amosite are produced in Canada, Russia, South Africa and Southern Rhodesia. Approximately 11 countries produce the remaining 15% of the world production.

There are literally hundreds of important uses for asbestos in manufactured products. In many of these asbestos constitutes an indispensable ingredient without which the produce would cease to exist. The greatest use of asbestos, both chrysotile and crocidolite, is in the manufacture of asbestos cement products. These products, manufactured in most countries of the world, consist of pipes, flat and corrugated sheets, shingles, and others. The second largest use of asbestos is in the manufacture of asphalt and vinyl asbestos floor tile. Additional products consuming large quantities of asbestos include asbestos papers, millboards, roofing felts, brake linings, roof coatings, caulking compounds, fillers, textiles and many others.

In any language the search for mining, processing, sales and usage of asbestos represents a most important industry in which almost every country in the world is involved in one or more ways.

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THE PHYSICAL AND MOLECULAR STRUCTURE OF ASBESTOS

SESSION 1, PAPER 2

by
Richard Gaze
The Cape Asbestos Company, Ltd., London, England

"Asbestos" is the generic name applied to all minerals having fibrous cleavage. A number of different minerals behave in this way but they may be classified in two distinct groups.

1. Fibrous Serpentine - The important member of this groups is CHRYSOTILE or WHITE ASBESTOS, an hydrated magnesium silicate; chemical formula $3MgO\ 2SiO_2\ 2H_2O$; specific gravity, 2.55. The fibres may be 2" or more in length but are usually much shorter. The finest fibres have a tubular structure and are some 150 to 400 Å in diameter. Crystal structure; hexagonal silica sheets superimposed upon a brucite-like layer of octagonal magnesium hydroxide. The sheets are uniformly contorted to form tubes or scrolls.

2. Amphibole Asbestos - The most important members of this group are CROCIDOLITE AND AMOSITE.
CROCIDOLITE OR BLUE ASBESTOS -- Sodium ferroso-ferric silicate, chemical formula $Na_2O\ 3FeO\ Fe_2O_3\ 8SiO_2\ H_2O$; specific gravity, 3.37. Fibre length up to 2" or 3" but commonly much shorter. Solid fibres, the finest usually between 500 and 1000 Å in diameter. Crocidolite has a distinct blue color and high resistance to acids and chemicals.
AMOSITE -- Ferrous magnesium silicate; chemical formula $1.5MgO\ 5.5FeO\ 8SiO_2\ H_2O$; specific gravity, 3.45. Fibre length up to 6" or more, although shorter grades are common. The fibres are solid, the finest being about 1000 Å in diameter. Whitish-fawn in color and having good acid and chemical resistance.
OTHER AMPHIBOLES -- Other fibrous amphiboles, Anthophyllite, Tremolite and Actinolite may also be encountered but are of little commercial importance in view of the much lower tensile strength of the fibres.
Crystal Structure of the Amphiboles -- The crystal structure of the amphiboles is based upon narrow layers or strips of hexagonal silica units interlocked on either side of a strip formed from an octahedral arrangement of cation-oxide units.

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THE DETECTION AND LOCALIZATION OF MINERAL FIBERS IN TISSUE

SESSION 1, PAPER 3

by
C. Berkley, J. Chung, W. E. Smith and I. J. Selikoff
The Mount Sinai Hospital, New York, N. Y.

A number of new techniques are described which enable (1) the tagging of individual fibers with fluorochromes in vivo for a period of at least one month and (2) facilitate the detection of otherwise "invisible" individual asbestos fibers and mineral particulates by electronic ashing of sections.

These techniques were designed for use (a) in experimental studies in animals to locate individual fibers in situ shortly after respiratory exposure and (b) in human biopsy or autopsy specimens in the absence of asbestos bodies.

Localization by electronic ashing has proven highly satisfactory. Variations in technical factors allow for correlation of fiber location with histological structures. Studies of the effect of ashing on asbestos bodies are also described. The advantages of the concomitant use of phase microscopy were demonstrated.

The results of the fluorochromes experiments raise the question of mechanical fixation of particulate carcinogens in tissue, as well as the adsorption and concentration of dilute carcinogenic agents.

SESSION 1, PAPER 4

IDENTIFICATION OF THE SEVERAL VARIETIES OF ASBESTOS FIBERS IN HUMAN LUNG TISSUE

by

A. Vorwald

Wayne State University, Detroit, Mich.,

(Abstract not received)

SESSION 1, PAPER 5

SOME OBSERVATIONS ON THE DUST CONTENT AND COMPOSITION IN LUNGS WITH ASBESTOSIS, MADE DURING WORK ON COAL MINERS PNEUMOCONIOSIS

by

G. Nagelschmidt

Safety in Mines Research Establishment, Sheffield, England

In the course of studies, made at the Sheffield Laboratory of S.M.R.E. during the last 15 years, of various types of lung dust diseases, and mainly of pneumoconiosis of coal workers, a few observations have been made on lungs with asbestosis.

After a review of the literature, methods of isolating and identifying different types of asbestos (chrysotile crocidolite, amosite) will be discussed.

Results will be presented for about 20 lungs with asbestosis, obtained from the London Pneumoconiosis Panel, which were studied several years ago. The types of asbestos which had caused the disease are not known and several types may have been involved. Preliminary data will be given for a number of asbestosis lungs with exposure to single known types of asbestos obtained from, and studied in cooperation with the Pneumoconiosis Research Unit of South Africa.

The main tentative conclusion is the following: Whereas in the pneumoconiosis of coal miners and in classical silicosis there is on average a clear positive correlation between amount of dust in the lungs and severity of fibrosis, this does not appear to be the case in asbestosis. This suggests that products of dissolution, perhaps polysilicic acid, cause the fibrosis. The data also suggest that in the lungs chrysotile is more soluble than crocidolite, and amosite may be less soluble than crocidolite.

SESSION 1, PAPER 6

ASBESTOS DUST DEPOSITION AND RETENTION IN ANIMALS

by

J. W. Skidmore and J. C. Wagner

M.R.C. Pneumoconiosis Research Unit, Glamorgan, Wales

In previous animal dusting experiments it has been established on histological grounds that there was a difference in the fibrogenic properties of different types of asbestos. Following the intrapleural inoculation of varieties of asbestos dust and silica into rats it has been shown that it is possible to induce pleural mesotheliomas with chrysotile, crocidolite, amosite and silica. The amount of dust inoculated into these animals was 20 mg. This appeared, by histological examination, to be greatly in excess of the amount found in the majority of human cases of pleural mesothelioma. Following the experiences of human cases in South Africa, it was expected that the mesotheliomas would occur in animals inoculated with crocidolite. In an attempt to clarify the position a series of dusting experiments were planned.

It was desirable, therefore, to produce an experimental method by which a known amount of dust could be deposited in the lungs of rats by an inhalation method. In addition, it was necessary to know whether the various types of asbestos were retained and had a similar histological distribution.

Groups of rats have been exposed to airborne dust clouds of chrysotile, crocidolite, amosite or powdered glass which served as a control inert and insoluble non-fibrous dust. Reasonably constant and equal weight concentration of dust in the aerodynamic range which could reach the pulmonary regions

SESSION 1, PAPER 6
(continued)

of the lung were maintained for each dust cloud. The inhalation extended over a period of six weeks, the rats being exposed for 7 hours a day on 5 days of each week. To observe any differential elimination rate the rats from each group were killed 1, 29 and 58 days after the end of exposure, histological sections were obtained from each rat lung and the weight of dust retained determined by reference to its silica content. The findings of this experiment will be discussed.

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SESSION 1, PAPER 7

EXPERIMENTAL ASBESTOSIS WITH FOUR TYPES OF FIBRES

by
J. Mills
University of Reading, Reading, England

The changes in the lungs of 49 rats exposed to chrysotile dust have already been described (Holt, Mills & Young, J.Path. & Bact. 15. 87.1964). The dust caused focal lesions, in which giant cells were prominent, followed by diffuse fibrosis. Finely divided dust was seen in the rat lungs but no asbestos bodies. It was concluded that fine asbestos dust could produce asbestosis in the rat.

Lung changes after exposing 66 guinea pigs to four types of asbestos are now described, chrysotile 27, crocidolite 17, amosite 12 and anthophyllite 10.

Duration of exposure varied from 3 to 78 days. Animals were killed at intervals extending from 3 to 420 days after first exposure to dust. The same long term results were obtained whether the total exposure was 3 days or 78 days.

After 3 days exposure asbestos dust could be found in the distal ends of alveolar ducts and in the surrounding alveoli, and there was an exudate of mononuclear cells and multinuclear giant cells which was most evident in the terminal bronchioles. Asbestos bodies, i.e. asbestos fibres coated with an iron containing material, have been identified after 14 days. Thereafter cell exudate extends into alveolar spaces and alveolar walls, generalized fibrosis follows and there is a steady increase in the size and number of asbestos bodies.

The dust seen in the lungs consists chiefly of very finely divided particles and evidence will be presented which suggests that these are more active in the production of lung fibrosis than the larger particles which produce asbestos bodies.

It is extremely difficult to control the spread of asbestos dust throughout the laboratory and the guinea pig lung is very sensitive to the inhalation of small amounts of this dust. In spite of the fact that experimental animals were exposed to the dust in sealed chambers, small amounts of dust gained access to the animal room and many of the untreated guinea pigs developed interstitial pneumonia.

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SESSION 1, PAPER 8

ELECTRON-MICROSCOPE STUDIES OF ASBESTOSIS IN MAN AND ANIMALS

by
J. G. M. Davis
University of Cambridge, Cambridge, England

In this paper are reported the results of some electron-microscope observations on the effect of asbestos dust on Guinea pig and Human lung material. In particular the fine structure of the asbestos bodies found in this material was examined. The guinea pigs were dusted at Reading University by the method of Holt and Young (1960). The human lung material was taken as a biopsy from an asbestos worker who had been exposed to asbestos dust for over twenty years.

Guinea pigs treated with asbestos dust developed several pathological changes in their lungs. These included the formation of nodular giant cell lesions, interstitial pneumonia in which the alveolar walls became infiltrated with dust carrying macrophages and complete lung consolidation and fibrosis in some areas.

Giant cells appeared to be formed by the aggregation of dust carrying macrophages and there is evidence to suggest that these macrophages can undergo conversion to fibroblasts. Although the sequence of events could not be followed in one human lung specimen, the same pathological lesions were present as found in the guinea pig lungs, namely nodular giant cell lesions, interstitial pneumonia and lung consolidation.

When asbestos bodies were found in either guinea pig or human lungs their coating material usually consisted of fine granular material that is probably ferritin. This material can be deposited in layers of varying density, and occasionally in guinea pigs the outermost layer exhibits a fibrous rather than a granular structure. Asbestos body segmentation appeared to be due to two different processes. In one, the segmented appearance resulted from the uneven deposition of the coating material in seperate globules, and in the other it was produced by the splitting of a previously smooth coat.

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SESSION 1, PAPER 9

RHEUMATOID FACTOR IN SERUM OF INDIVIDUALS EXPOSED TO ASBESTOS

by
B. Pernis and E. C. Vigliani, University of Milan, Milan, Italy, and
I. J. Selikoff, The Mount Sinai Hospital, New York, N. Y.

(Abstract not received)

SESSION 1, PAPER 10

OBSERVATIONS ON THE PATHOGENESIS OF ASBESTOSIS

by
E. C. Vigliani and B. Pernis
University of Milan, Milan, Italy

(Abstract not received)

SESSION 2, PAPER 1

ASBESTOSIS IN GREAT BRITAIN

by
J. C. McVittie
Ministry of Pensions and National Insurance, London, England

A whole new literature relating to asbestos appeared in Great Britain between 1927 and 1932. The Report by Merewether and Price in 1930 was outstanding and established the occupational origin of asbestosis. It was made clear that the principal safeguard against the ill effects of asbestos dust on the lungs was to be found in improved ventilation and dust suppression. Asbestosis became a compensatable disease. Initial and periodical examination of workers in certain scheduled processes were instituted and specific instructions were issued regarding exhaust ventilation, dust prevention, etc. Case finding arises in two ways: from the statutory periodical medical examinations and from applications for compensation under the Workmen's Compensation Acts and from applications for benefit under the Industrial Injuries Act which superseded the Workmen's Compensation Acts in 1948. This is probably the only source of information about the prevalence of asbestosis in the country. Tables give the number of cases diagnosed each year since 1931 and a special breakdown of 248 cases diagnosed between 1955 and 1963. These show that 169 of these 248 cases entered the industry after 1931. They show the numbers resulting from periodical medical examinations and from applications. The clinical, radiological and pathological features of the disease are described and diagnostic criteria indicated. The effects of asbestosis, e.g. disablement, morbidity, liability to other pulmonary and pleural disease, and mortality are discussed. Against this background the value of periodical examinations is examined.

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SESSION 2, PAPER 2

ASBESTOSIS AMONG INSULATION WORKERS IN THE UNITED STATES

by
I. J. Selikoff, J. Churg, and E. C. Hammond
The Mount Sinai Hospital, New York, N. Y.

Large scale studies of asbestosis in the past have been restricted to workers employed in asbestos textile factories. This was true both of the important basic investigations of Merewether in Great Britain (363 employees) and of Dreessen and his colleagues in the United States (541 employees).

There have been scattered reports of pulmonary asbestosis and its complications in workers exposed to asbestos in industries other than textile. However, the absence of satisfactory epidemiological data has made it difficult to assess the risk of such exposure. Yet such assessment is important since it is likely that asbestos textile workers now represent only a minority of those exposed to asbestos in industry.

Investigations reported here were concerned with 1,522 members of the International Association of Heat & Frost Insulators and Asbestos Workers, in the New York-New Jersey Metropolitan area, a union of insulation workers. This study included every individual who was a member of this union December 31, 1942 or who joined by December 31, 1962.

261 men were dead on January 1, 1963; 43 have died since. Each death has been studied. 1,258 were alive; 1,117 were examined (89.9%), including 131 of 169 no longer working in the trade and 986 of the 1,026 working members. Clinical, radiological and pulmonary function examinations were made.

1. Prevalence of asbestosis: Correlation of radiological abnormality with lapsed time from onset of exposure.

Time lapsed from onset of Exposure	Number Examined	RADIOLOGICAL ABNORMALITY (Asbestosis) (Grade) 0	1	2	3
40+ (years)	121	7 (5.8%)	35	51 (94.2%)	28
30-39 "	194	25 (12.9%)	102	49 (87.1%)	18
20-29 "	77	21 (27.2)	35	17 (72.8%)	4
10-19 "	379	212 (55.9%)	155	9 (44.1%)	0
0-9 "	346	310 (89.6%)	36	0 (10.4%)	0
	1,117				

2. Analysis of 307 consecutive deaths among asbestos insulation workers January 1, 1943 - August 31, 1964.

Carcinoma of lung*	53	
Mesothelioma*	9	
G. I. Carcinoma*	35	
Other neoplasms*	27	124
Asbestosis	17	
All other causes	166	

*To be further reported by Dr. Hammond.

3. Presence of pulmonary asbestosis on histological examination of lung parenchyma of 39 consecutive insulation workers.

	No.	PULMONARY FIBROSIS 0	1	2	3
1. With lung CA/ pleural mesothelioma	16	0	3	4	9
2. All other	23	0	10	7	6
	39	0	13	11	15

It is concluded that pulmonary asbestosis is a significant risk of insulation workers in the United States at this time.

Addendum. Adequacy of sample- Total U.S. Membership, IAHFIAW, 1963 -------- 14,803
Total N.Y. - N.J. Membership, IAHFIAW, 1963 -- 1,258
Examined 1,117

However, these data do not include the following insulation workers.

1. Non-union insulation workers.
2. Maintainence insulation workers.
3. "Sprayed insulation" workers.
4. Insulation work as part of other trades (oil-burner and boiler repair, railroad, sheet-metal, laborers, etc.)
5. Insulation workers in other unions (longshoremen, shipbuilding).

SESSION 2, PAPER 3

MORTALITY RATES AMONG ASBESTOS PRODUCTS WORKERS IN THE UNITED STATES

by
P. Enterline
U. S. Public Health Service, Washington, D.C.

(Abstract not received)

SESSION 2, PAPER 4

SECULAR CHANGES IN ASBESTOSIS IN AN ASBESTOS FACTORY

by
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The Cape Asbestos Company, Ltd., London, England

A factory in the east end of London has been manufacturing asbestos products for over 50 years. Since 1930 workers from this factory have been the subject of many independent studies by various clinicians and researchers. The clinical findings reported in four previous publications are compared with a series of 24 new cases presented for the first time in this paper. One of these was diagnosed 12 years after the last exposure. Changes in type and length of exposure, in signs and symptoms, in diagnostic techniques and in evaluation of pensionable disability are noted over the years since the disease became subject to compensation.

There has been a steady increase in the average number of years of exposure required to produce certifiable disability from 7 years to 17 years.

As some signs and symptoms considered characteristic by earlier writers have become less common, others have gained prominence. Search for the classical xray picture has given place to attempts to

demonstrate significant changes in a chronological series of films. Pulmonary function studies have become an important technique in diagnosis and assessment of disability.

In a small group of 10 cases with 10 controls matched for age, sex and length of exposure, the evidence for the influence of pulmonary infection has proved inconclusive.

The changes in pathology of asbestosis are noted by comparing two series of post-mortem reports on workers from the same factory. In 1949 Wyers published the findings in 115 cases of asbestosis at death. The present series of 71 post-mortems since 1957 shows much less frequency of tuberculosis as a complication but increased occurrence of malignancy of the lungs. Emphysema has become less common. Primary malignancy of the pleura and peritoneum occurs with a frequency unsuspected in the earlier reports.

The mean age at death has risen from 40.8 to 57.3. The average duration of the disease has lengthened from 6.4 to 10.9 years. The longest interval between last exposure and diagnosis is 38 years, one year before post mortem.

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SESSION 2, PAPER 5

OCCUPATIONAL AND NON-OCCUPATIONAL EXPOSURES TO ASBESTOS

by
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The enormous rise in the production and industrial use of asbestos during the past 50 years has resulted in markedly widened exposure to asbestos dust for a greatly increased number and variety of workers. Some of them, moreover, sustain such contacts incidentally either when being employed in various capacities in operations where asbestos products are processed, used, or handled or when working in plant areas in which an environmental pollution of the air with asbestos exists. The harmful effects of such growing exposures to asbestos during the past two decades are reflected not only in a growing number of reports on the occurrence of asbestosis and asbestos cancer in a variety of asbestos workers, but also in the fact that such reports originate from a rising number of countries in some of which such observations were made only recently for the first time. Information on the number and variety of exposed workers and on the occurrence and incidence of asbestosis and of asbestos cancers among them is most fragmentary in all countries, especially in the United States and Canada, one being the principal consumer of asbestos and the other the chief producer of this mineral. It is for this reason that regrettably, the original plan of having a recent epidemiologic survey on these aspects of asbestos production in Canadian mines and mills be undertaken under the aegis of the National Cancer Institute of Canada was not adhered to, and that this study was carried out as an industry-dominated venture which yielded highly controversial negative results. The principal worker groups exposed to respiratory contact with asbestos are employed in the asbestos mining and milling industries, in the production and commercial use of asbestos cement and plaster and their numerous secondary products, in the production and application of asbestos for insulating purposes and in the processing of asbestos and its manufacture into textiles. Protection of asbestos workers against occupational health hazards related to respiratory and cutaneous contact with asbestos by workmen's compensation laws are in many countries and States more or less defective and, therefore, inadequate.

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SESSION 2, PAPER 6

ASBESTOS AND THE URBAN DWELLER

by
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University of Cape Town Medical School, Cape Town, South Africa

The extent of inhalation of asbestos fibres by urban dwellers was investigated by counting asbestos bodies in smears from the lung bases from 500 consecutive autopsies in subjects over the age of 15 in Cape Town, South Africa, and 500 in Miami, Florida. The results were similar in the two cities and no less than 30% of the males and 20% of the females showed asbestos bodies. In 80% of the positive cases the bodies were scanty, were not associated with pulmonary changes, and were regarded as the result of contamination of the urban atmosphere. In 6% of the males the bodies were numerous and were presumably of occupational origin.

The tendency for asbestos fibres too long to be phagocytosed to move downwards by gravity before they become asbestos bodies leads to concentration at the lung bases, and small doses can have a cumulative effect. An increase in the amount of urban air contamination would seem inevitable in view of the increasing consumption and diversity of uses of asbestos and of its virtual indestructibility, and an increase in basal asbestosis is suggested as a possible future development. As a limited basal asbestosis may be associated with malignant mesothelioma of pleura and peritoneum an increase in this tumour is forecast as the main ground for regarding asbestos as a potential urban hazard. While that view is conjectural, the finding of abundant asbestos bodies in the lung bases of 1 in 17 of the male hospital population suggests that the occupational hazard from asbestos is greater and more diversified than is at present realized.

The main object of this work is to draw attention to the effects of a relatively new development,

SESSION 2, PAPER 6
(continued)

the widespread use of asbestos in cities, and to stimulate the obtaining of comparable figures from other parts of the world, to establish the base-lines of urban asbestos inhalation of today, and enable us to detect increases in the future.

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SESSION 2, PAPER 7

ASBESTOSIS IN SOUTH AFRICA: CERTAIN GEOGRAPHICAL AND ENVIRONMENTAL CONSIDERATIONS

by
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Miners' Medical Bureau, Department of Mines, Johannesburg, South Africa

Two major asbestos mining areas occur in South Africa; one in the North West Cape, the other in the Northern Transvaal. These areas are 300 miles apart and there is little exchange of population among them. Available evidence indicates that the high prevalence of pleural mesothelioma in the North West Cape does not occur in the Northern Transvaal.

Although the population at risk in the Northern Transvaal is appreciably smaller than in the North West Cape this cannot account for the absence of the phenomenon there, especially as medical facilities are of equal standard in the two areas.

Mineralogical differences in the two areas occur but are of obscure significance. The history of the mines, intensity of production, and environmental pollution resulting from mining activities appear to run parallel in the two areas. Dust levels in the mines and mills were higher in the North West Cape throughout the period for which recorded measurements are available.

Medical epidemiological investigations indicate a higher prevalence of asbestos bodies in the sputum of a random sample of inhabitants of the North West Cape Asbestos area than in the Transvaal area. This applies for both the industrially exposed people and the neighbourhood population.

The prevalence of asbestos fibres in the sputum was remarkably similar for all groups in both areas. The significance of these findings is discussed.

Radiological observations on random samples of the two populations strongly suggest the occurrence of asbestosis in non-industrially exposed persons in the two areas, more so in the North West Cape. Post-mortem data do not indicate greater prevalence or severity of asbestosis in the North West Cape industrially exposed persons despite the dustier conditions.

None of the factors examined explains satisfactorily the absence of mesotheliomas of the pleura in the Transvaal.

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SESSION 2, PAPER 8

PLEURAL PLAQUES AND ASBESTOS: FURTHER OBSERVATIONS ON ENDEMIC AND OTHER NON-OCCUPATIONAL ASBESTOSIS

by
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Tampere Central Hospital, Tampere, Finland

Some hundred cases of pleural calcification of the type characteristically seen among asbestos workers were found in people not employed in the mining industry but who lived in an area near two asbestos mines in Eastern Finland. These may be called cases of endemic asbestosis regardless of the type or degree of pulmonary reaction or fibrosis. Radiological and clinical signs of pulmonary fibrosis were not present in most of these cases of pleural calcification. Since the first report of endemic asbestosis in 1960 some pulmonary function tests have been performed on these cases and will be briefly outlined.

The incidence of pulmonary cancer in Finnish men is very high, especially in eastern parts of the country, being six times higher than that in Norway. Coincidence of endemic asbestosis and pulmonary cancer has been observed in 23 cases by the author. The problem of establishing a causal relationship between asbestosis and pulmonary or pleural malignancies will be discussed.

Over the past 18 months, 77 similar cases of pleural calcification have been found in routine chest examinations at the Roentgen department of Tampere Central Hospital in central Finland where there are no asbestos mines. The etiological problems in these cases will be discussed with particular reference to asbestos and other dusts. As asbestos dust is indestructible and insoluble, brief exposures may result in pleural or pulmonary fibrosis many years later.

In typical cases of parietal pleural calcifications the roentgen diagnosis is easy, but before calcification of the pleural plaques takes place the diagnosis is difficult. Some roentgen diagnostic observations will be presented.

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SESSION 3, PAPER 1

INHALATION OF FIBROUS DUSTS

by
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Asbestos fibres 50 microns and longer are found in alveoli, whereas few of the particles of near spherical shape present have diameters greater than 10 microns. There is no inconsistency here as the effectiveness of each of the two mechanisms, sedimentation and inertial precipitation, operating to deposit particles in the upper respiratory tract is determined by particle falling speed, which depends on shape and density as well as "size." For a fibre it is the diameter and not the length which mainly determines falling speed. Asbestos fibres can be long and yet be so fine that deep penetration of the respiratory system becomes possible.

Measurements of falling speed, diameter and length, on glass fibres, chosen for their exact cylindrical form, have provided the relationships between these parameters. For a given diameter, increasing the length/diameter ratio from 1 to 10 results in a fourfold increase in the falling speed. For higher length/diameter ratios the falling speed is proportional to the square of the diameter and almost independent of the length. Results of similar measurements on the less uniform fibres of amosite, chrysotile and crocidolite show the same tendencies. The falling speed of an asbestos fibre, for example, 3 microns in diameter, 300 microns long, is comparable to that of a unit density sphere 10 microns in diameter.

The possibility of long fibres penetrating to the pulmonary space has necessitated consideration of their capture in fine airways. The rate of capture by virtue of length has been calculated for places where it is likely to be significant, for example, on the nasal hairs and at branching of airway

Some aspects of dust sampling asbestos particles are discussed in the paper.

####

SESSION 3, PAPER 2

A COMPARISON OF IMPINGER AND MEMBRANE FILTER TECHNIQUES FOR EVALUATING AIR SAMPLES IN ASBESTOS PLANTS

by

E. E. Ayer, J. R. Lynch and J. H. Fanney

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In the United States the threshold limit value of 5 million particles per cubic foot for asbestos is based on samples taken by impinger and counted in liquid by use of a microscope with a 16 mm objective. Dust concentrations in the asbestos textile industry have been evaluated by this method for 30 years. It is recognized that the measurement is only an indirect estimation of the potential hazard from asbestos in that asbestos fibers comprise only a very small fraction of the dust count.

In an environmental study of the asbestos handling and processing industries now under way samples have been taken both by impinger and membrane filter. Companion samples by the two methods have been used to determine the relationship between impinger dust counts by the 'standard method' and fiber counts on transparentized membrane filters by use of a microscope with a 4 mm phase contrast objective. In spite of the large variances associated with each of these counting methods, a relationship between results they yield was developed. In general, more fibers were associated with a given impinger dust counting in carding operations than in other operations. The relationships of fiber count to impinger count and the count of fibers longer than 10 microns to the impinger count are presented by operation in this paper. Tentative results suggesting a fiber count equivalent to the present threshold limit are also presented and discussed. In addition, size distributions and determinations of "respirable" dust are briefly discussed.

####

SESSION 3, PAPER 3

DEVELOPMENTS IN DUST SAMPLING AND COUNTING TECHNIQUES IN THE ASBESTOS INDUSTRY

by

S. Holmes

Turner Brothers Asbestos Co. Ltd., Rochdale, England

Due to the fibrous nature of asbestos dust, the sampling and analysis of factory atmospheres in the asbestos industry has presented special problems which have been the subject of continuous investigation over the past 20 years, first by the individual manufacturing companies and later as part of the research program of the Asbestosis Research Council. The aim of this work has been to agree on a sound and reliable method of sampling and counting which will enable true comparisons to be made between dust conditions at different processes and in different factories.

This paper traces briefly the development of sampling and counting methods leading up to the long running thermal precipitator and membrane filter techniques. The relative merits of these two methods are discussed and reasons are given to show why the membrane filter is now preferred. Colored membrane filters suitable for dry counting are described, as well as the more usual white membranes which can be cleared for wet counting. Results using the two systems are compared.

A description is given of the microscopic techniques used in sample counting and attention is drawn to the difficulties which can arise due to the crystalline nature of asbestos dust. One result of this is that care must be taken in choosing a liquid of suitable refractive index to clear the membrane and a number of such liquids are mentioned.

Brief reference is made to recent work in which, by clearing the membrane with a liquid of high dispersion, use can be made of the dispersion staining technique in viewing the sample. In this way, it is possible that the individual components of samples containing mixed asbestos dusts may be identified.

####

DUST MEASUREMENTS AND MONITORING IN THE ASBESTOS INDUSTRY

by
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British Belting and Asbestos, Ltd., Yorkshire, England

The commonly used methods for estimating atmospheric asbestos dust concentrations involve the collection of a sample followed by a count under the microscope. These methods are slow and laborious and involve skilled or trained operatives. In consequence it has always been difficult and generally impossible to carry out sufficient tests to give reliable results. The big fluctuations of concentration which may occur at one test position in an asbestos work room aggravate the difficulties.

A good deal of attention has recently been paid to Tyndallometer methods of monitoring factory atmospheres, more especially at the other end of the pollution scale, the monitoring of dust free atmospheres for medical, photographic and electronic work.

The Asbestosis Research Council in England has done a good deal of work on the use of light scattering methods. Recently work has been carried out on the "Royco" Particle Counter (Royco Instruments Inc., Menlo Park, California). This works on the light scattering principle but by virtue of a very small cell which accepts one particle at a time, and a pulse height discriminating and counting system, it is capable of counting and sizing particles.

The results obtained over a period of 7 months in an asbestos factory are described. During this period a comparison has been made of its figures with those of the membrane filter. Remarkably good agreement has been found.

It is believed that with this instrument a continuous survey can now be maintained in an asbestos factory, without the very large cost of trained microscopists needed to carry out much more limited surveys by the commonly used methods. Moreover, since a dust figure can be obtained in 20 seconds, high concentrations occurring for very short periods which might otherwise be overlooked may also be discovered.

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SESSION 3, PAPER 5

MEASUREMENT OF AIRBORN ASBESTOS DUST BY INSTRUMENTS MEASURING DIFFERENT PARAMETERS

by
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(Abstract not received)

SESSION 4, PAPER 1

PRESENT THRESHOLD LIMIT VALUE IN THE U.S.A. FOR ASBESTOS DUST: A CRITIQUE

by
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Asbestos is a generic term applying to a number of mineral silicates that are incombustible in air and can be separated into filaments. That exposure to asbestos is associated with development of a potentially disabling pneumoconiosis in man has been amply demonstrated by industrial experience. The present threshold limit value of 5.0 millions of particles per cubic foot (m.p.p.c.f.) of air relates to the prevention of asbestosis. This value was adopted by the American Conference of Governmental Industrial Hygienists following a recommendation by Dreessen, DallaValle, Edwards, Miller, and Sayers, after a study of 541 employees in three asbestos textile plants using chrysotile. Only 3 doubtful cases of pneumoconiosis were found in those exposed to dust concentrations under 5 m.p.p.c.f., whereas numerous well-marked cases were found above 5 m.p.p.c.f. Evaluation is made of the conditions of the study by Dreessen and his colleagues and the applicability of a standard derived under such specific conditions to current industrial use.

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SESSION 4, PAPER 2

ECONOMICS OF DUST CONTROL

by
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Turner Brothers Asbestos Co. Ltd., Rochdale, England

A brief historial introduction is given about conditions in the U.K. asbestos textile industry in the late 1920's and early 1930's; reference is made to the 1931 conference between employers and the Home Office that resulted in a code of practice being established for dust suppression in asbestos textile factories. Details are given of the various methods used for dust control in the Companies factories together with the cost of these measures. Some figures are also given for the cost of dust control at the Cape Asbestos Co. Ltd's new Amosite Mill at Penge. Current work on improving dust control is discussed together with the part now played in this by the Asbestosis Research Council.

###

RADIOLOGICAL CLASSIFICATION OF PULMONARY ASBESTOSIS

by
H. Bohlig
Municipal Hospital, Lüdenscheid, Germany

Every classification is imperfect, even more so regarding asbestosis. The classifications now in use are not quite identical, but they mainly divide the radiological appearances into three fluently changing stages, of which especially the second is illogically defined and not to be produced efficiently. Because the national differentiation between the compensation rules only a mere radiological classification can be taken into consideration for international agreement. The fact of this conference taking place at all proves that new international agreements about a practicable classification for pulmonary asbestosis are necessary. If experts agree that linear opacities are also disseminated shadows and that the radiological appearances of pneumoconioses can be only either disseminated or squared opacities, it would seem appropriate to adopt these two kinds of appearances as a base for new classification. Doing so, considerable approximation to already existing classifications (Sydney 1950; Geneva 1958) would be gained as well. For intensifying the reproducibility of the X-ray film and, on the other hand, enlarging the distinctness of the codified X-ray findings, we suggest not to use the unalterable symbol "L" (Geneva 1958), but to introduce another symbol "f" for linear patterns, chiefly occurring in asbestosis, and to combine it with the quantitative categories for small opacities (Geneva 1958). The large opacities might be characterized by the symbol "A" for beginning confluence and by "B" and "C" for opacities having longer diameter than 5 cm. The additional symbols (Geneva 1958) would mean welcome for further accommodation of the findings code to individual, local or national peculiarities. Extensive reconstruction of the radiological appearances, even without the film in question, would be possible when adopting the symbol suggested. It is unimportant whether this proposition is adopted or not; it is exceedingly important that some international agreement should be attained which would be really practicable.

####

ROENTGENOLOGICAL STUDIES OF PLEURAL CALCIFICATION IN ASBESTOSIS

by
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The Mount Sinai Hospital, New York, N. Y.

Although scattered instances of pleural calcification had been noted 25 years ago (Gloyne, Viglieni), these were considered coincidental or ignored. Such evaluation was strengthened by the negative findings of A.R. Smith in 1952.

Recently, attention has again been called to the association of pleural calcification with exposure to asbestos under industrial conditions (Jacob, Bohlig, Muller) and following environmental community exposure (Kivilucto).

Data are presented here which demonstrate that pleural calcification is frequently found among asbestos insulation workers and suggest that asbestosis is perhaps the most common cause of pleural calcification in industrial countries at present, especially when such calcification is bilateral.

1. Analysis was made of the results of x-ray examinations of 1,117 asbestos insulation workers (see Selikoff, Churg and Hammond, this conference).

Pleural Calcification on X-Ray Examination of 1,117 Asbestos Insulation Workers

Lapsed time from onset of exposure	No. Examined	Pleural calcification: Extent of calcification 0	1	2	3
40+ years	121	51 (42.1%)	37	20 (57.9%)	13
30-39 "	194	127 (65.4%)	46	15 (34.5%)	6
20-29 "	77	69 (89.6%	8	0 (10.4%)	0
10-19 "	379	374 (98.9%)	5	0 (1.1%)	0
0-9 "	346	346	0	0	0
	1,117				

Data is presented to indicate that both total exposure in years and lapsed time from onset of exposure are of importance, with the latter probably of greater consequence.

2. Almost half of the instances of calcification were bilateral (73 of 150). This tendency especially noted in more extensive calcification (29 of 35 Grade 2 and 19 of 19 Grade 3). When radiologically unilateral, the left side was more commonly involved (49) than the right (28).

3. Illustrations will be given of the variable location of plaques (diaphragm, costal, anterior and posterior mediastinal, pericardial, apical, interlobar fissures), their appearance and radiological demonstration.

SESSION 4, PAPER 4
(continued)

4. Attention is called to two simple x-ray maneuvers which have been found valuable: oblique projections and use of higher penetration kilovoltages. Both were routinely used in addition to the standard PA projection, in this investigation.

###

SESSION 4, PAPER 5

DIFFERENTIAL DIAGNOSIS IN THE PATHOLOGY OF ASBESTOSIS

by
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The study is based on workers in the manufacture or use of asbestos products. It does not include asbestos miners in whom there may be a mixture of silicosis and asbestosis. The differential diagnosis is considered under three main headings:

1. The distinction between asbestosis and other forms of diffuse fibrosis.
2. The distinction between asbestosis and pneumoconiosis due to other silicates.
3. The distinction between asbestos bodies and haemosiderosis of elastic tissue which may mimic asbestosis.

1. The fibrosis in asbestosis is often diffuse and associated with honeycomb (cystic)lung. The distribution of the fibrosis is helpful in distinguishing from other causes of honeycomb lung such as diffuse systemic sclerosis, eosinophilic granuloma and idiopathic fibrosis. Whole lung sections are of value in the differentiation.

When the asbestosis is in the form of massive fibrosis the possibility of the contribution of other diseases such as organized pneumonia or silicosis should be borne in mind.

2. The distinction of asbestosis from pneumoconiosis due to talc, mica and kaolin is not usually difficult but asbestos type bodies are present in talcosis in which some fibres may in fact be asbestos.

3. An important distinction is between asbestos bodies and haemosiderosis of elastic tissue. Fragmentation of elastic tissue and encrusting with haemosiderin occurs in pulmonary hypertension and appears to be related to interstitial haemorrhage and is unrelated to occupation. It is proposed that these structures be called 'elastosis bodies." It is also proposed that bodies similar to asbestos bodies formed from dust such as spicules of coal should be included under the generic name "Mineral fiber bodies" instead of the currently used term "curious bodies."

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SESSION 4, PAPER 6

RADIOLOGICAL-PATHOLOGICAL CORRELATIONS IN ASBESTOSIS IN UNITED KINGDOM AND REPUBLIC OF SOUTH AFRICA

by
K. F. W. Elmes, Brompton Hospital, London, England,
J.C. McVittie, Ministry of Pensions and National Insurance, London, England,
C. P. Theron, G. K. Sluis-Cremer and J. C. Wagner
Pneumoconiosis Bureau, Johannesburg, South Africa

A classification of radiological changes encountered in asbestosis has been designed by modifying the I.L.O. radiological classification for Pneumoconiosis. This has been used by a panel of readers in the United Kingdom and South Africa on radiological material drawn from both countries. The value of the classification will be discussed.

The classification was then applied to two series of x-rays, one from the United Kingdom and the other from South Africa where the diagnosis of asbestosis had been confirmed by pathological examination.

Certain radiological differences between the United Kingdom and South African material were noted and these will be discussed.

A copy of the radiological classification follows: The radiological classification is an extension of the I.L.O. classification. Symbols common to the two have the same definitions. Additional definitions are as followed:

Linear shadows -- the coarse variety is defined as those of greater than 1 m.m. in width.
1, 2, and 3 indicate extent in the same degrees as for nodulation.
Pleural changes -- D,M,W,F, indicate diaphragmatic medi-iastinal chest wall and fissures respectively. Calcified pleural thickenings are recorded separately.

The new additional symbols are-

1. "me" indicating appearances suggestive of pleural mesothelioma.
2. "ca" indicating bronchial carcinoma.
3. "cy" indicating cystic changes.

The symbol "pl" has been deleted from the additional symbols and added to the definitive changes indicating pneumoconiosis.

(Tables will be contained in the published proceedings).

####

PULMONARY FUNCTION IN ASBESTOSIS: SERIAL TESTS IN LONG TERM PROSPECTIVE STUDY

by
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Ten years ago, a group of 17 actively employed asbestos factory workers was evaluated clinically, radiologically and by means of pulmonary function tests. The plant in which the men were employed discontinued operations at this time; therefore, they had no further industrial asbestos exposure. Nevertheless, they were maintained under observation to study the natural history of established pulmonary disease uncomplicated by further exposure. Annual clinical, radiological and pulmonary function studies were undertaken, as well as management of intercurrent illnesses.

During the baseline studies, pulmonary function examinations, when abnormal, revealed the classic findings of the alveolar capillary block syndrome; uniform decrease in lung volumes, well preserved maximum breathing capacity, decreased arterial oxygen saturation (especially on exercise), normal pCO_2 values, and decreased diffusing capacity. Hyperventilation at rest and exercise occurred in more than half the cases, and while dead space ventilation was increased, alveolar ventilation was also increased. The most sensitive index of impaired function was arterial oxygen saturation. Slight reduction at rest was found in six and reduction below 92% was found in half the workmen on exercise. Poor correlation existed between impaired function and intimacy and duration of exposure. Better but still not parallel correlation was found with radiographic findings.

The post-employment serial evaluations were made in terms of x-ray progression, development or worsening of dyspnea on exertion and further measurements of pulmonary function.

Follow-up observations were limited by complications of the disease being studied.

1. 8 men are dead: 2 of lung cancer, 1 of pleural mesothelioma, 2 of gastric carcinoma, 2 of pulmonary asbestosis (cor pulmonale) and 1 of myocardial infarction.
2. 9 are alive, 1 following resection of lung cancer.

With this limitation, long term follow-up results are described with correlation with clinical and radiological features. Original observations on pulmonary compliance and pulmonary airway resistance in these men are discussed with relation to vital capacity and maximum breathing capacity.

SESSION 4, PAPER 8

ROUTINE LUNG FUNCTION STUDIES ON 630 EMPLOYEES IN AN ASBESTOS PROCESSING FACTORY

by
Ross Hunt
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Routine work in this field was started in July 1960 in an asbestos textile plant in the North of England. The aim was to create a set of normal figures for lung compartment volumes, gas transfer factor coefficients, 90% mixing indices, ventilation on exercise, and forced breathing capacities. The subjects used in these tests were volunteers of both sexes in varying age and stature groups from departments other than those processing asbestos. These results were then analysed statistically and the regression formulae obtained applied to the results of men and women working in 'scheduled' and 'exposed' occupations. The conclusions drawn from these results were aligned with the X-ray and clinical findings in each case. Pulmonary function tests were also used as a screen to prevent people with lung impairment from taking up work in departments where asbestos dust was prevalent. Some difficulties were encountered in the beginning, both in subject response and sampling technique, but these were overcome and this paper deals in the main with the technique and results obtained over the past 3 years. The evidence points to a significant decrease in gas transfer and vital capacity before any radiological or clinical signs are evident.

The work continues as a routine test procedure carried out in the firm's medical centre. Approximately eight people are examined each day, the intention being to examine all 'scheduled' and 'exposed' personnel once a year at least, and more often if their results give cause for concern. A modified single-breath-holding sampling technique is used and is described in the paper.

SESSION 4, PAPER 9

THE DISCRIMINANT VALUE OF PULMONARY FUNCTION TESTS IN ASBESTOSIS

by
M. L. Thomson, Anne-Marie Peltier and W. J. Smither
London School of Hygiene and Tropical Medicine, and
Cape Insulation and Asbestos Products Ltd., London, England

A clinical, radiographic and pulmonary function evaluation has been made on 19 workers in an asbestos factory certified as having asbestosis, and on a further 9 exposed, but uncertified workers. The clinical and radiographic assessments were made, using a 2 or 4 point scale, by one of the authors without knowledge of the pulmonary function results.

Of the clinical features, radiography, dyspnoea and rales have the greatest discriminating

power, indicating that the Pneumoconiosis Board was mainly relying on these features in certifying the workers, and in this they were in agreement with a group of experts who were asked to rank a list of clinical features according to their value in diagnosing and assessing the degree of asbestosis.

After standardizing the results, where necessary, against body size, the discriminating ability of the pulmonary function tests has been assessed, using the criterion of certification. Inspiratory capacity and vital capacity were found to have the best discriminant power, followed by diffusing capacity. As expected, the ratios, residual volume / total lung capacity and forced expiratory volume (F.E.V.(1)) / vital capacity, and the pulmonary capillary blood volume had negligible discriminant power.

The airway conductance (by body plethysmograph), peak flow rate and F.E.V.(1) have been measured on a further group of 16 certified asbestos workers, and a control group of 15 workers not directly exposed to asbestos. Although conductance showed a wide scatter, the mean was similar to that of the control group and the same as that of a further normal group of 82 staff of this School, and this in spite of the universal reduction in lung volume and evidence of bronchial inflammation in many of the asbestosis patients. It is inferred that in these patients the bronchi do not participate in the shrinkage of the lung parenchyma, possibly because of a strong force exerted radially outwards on the walls by the surrounding fibrous lung. The peak flow correlated more highly than F.E.V. with conductance and appeared to be the more valuable of the two simpler tests for assessing bronchial patency in this disease.

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SESSION 5, PAPER 1

STUDIES OF CARCINOGENESIS OF ASBESTOS FIBERS AND THEIR NATURAL OILS

by
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Three types of asbestos are used industrially, amosite, crocidolite and chrysotile. The first two of these but not the third contain appreciable amounts of natural oils. The three types of native asbestos, oil-free amosite and oil-free crocidolite, and the oils derived from amosite and crocidolite are being tested for carcinogenicity in rats and mice, the fibers by subcutaneous injection after suspension in saline, and the oils by repeated application to the skin. Asbestos is often transported or stored in jute sacks and the oil from the jute fibers is absorbed to an appreciable extent by all three types of asbestos. Samples of jute oil are being tested for carcinogenic and co-carcinogenic activity on mouse skin. Other possibilities of contamination of asbestos with carcinogenic materials are also being investigated. It is hoped that these investigations will lead to a clearer definition of the carcinogenic hazards associated with exposure to asbestos, and at the same time to the development of suitable systems in which the mechanisms of carcinogenesis by asbestos can be studied in greater detail.

At present the following possible mechanisms are under consideration:

(a) that carcinogenesis is due to the presence of carcinogenic polycyclic hydrocarbons or other organic materials in the natural or contaminating oils.

(b) that it is due to the presence of certain metals and metal-complexes in asbestos. Several metal complexes, especially those containing iron, have been shown to induce cancer, and several metals, including chromium, nickel, lead, etc., are carcinogenic in their own right. Appreciable amounts of nickel and chromium have been found in chrysotile.

(c) that there is an Oppenheimer Effect, that is, cancer induced by the prolonged residence in the tissues of chemically-inert material incapable of being removed by phagocytosis.

One of the more intriguing features of asbestos carcinogenesis is the fact that in the case of pleural and peritoneal mesotheliomata the cancers develop at sites remote from those exposed. Special studies are being made, therefore, on the migration of inhaled or injected asbestos fibers in experimental animals.

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SESSION 5, PAPER 2

CHEMICAL STUDIES OF ASBESTOS

by
J. S. Harington
Royal Cancer Hospital, London, England

The natural oils and other organic matter associated with crocidolite and amosite asbestos have been preliminarily examined by various techniques. A number of polycyclic aromatic hydrocarbons from both types of oil have been identified.

The yields of oil obtained after extraction of fibers with suitable solvents under defined conditions range from 0.03 to 1% for both types of asbestos. Mass extraction of large amounts of amosite and crocidolite gave yields of 0.3% (300 mgm. oil/100 gm. fiber). More oil appears to be present on crocidolite than on amosite though there may be considerable variation from one type of asbestos to another and within any one sample. There are also indications that crocidolite oil differs in composition from amosite oil.

In addition to the oils naturally associated with certain types of asbestos, secondary contaminating oils may sometimes be found. Experiments have shown that asbestos fibers may absorb up to 75% of jute oil from the jute sacks in which the asbestos is commonly stored or transported. Trace amounts of polycyclic aromatic hydrocarbons were found in samples of jute oil and at least one sample was shown to possess tumor-promoting activity after tests on the mouse skin. In some cases, oil emulsions are added intentionally to fibers to facilitate processing.

Since the biological activity of asbestos may be due, at least in part, to the metal-complex nature of its structure, analyses for iron in asbestos and other minerals were carried out. Correlations are being sought between the content of ferrous and ferric iron and the biological activity of different minerals. Spectrographic analyses have shown the presence in chrysotile of relatively high concentrations of chromium and nickel, both of which are recognized as carcinogenically active.

As part of this project, the elution of metals by serum under defined experimental conditions has been investigated.

Methods for the identification of asbestos fibers in histological preparations and tissues have been developed.

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SESSION 5, PAPER 3

PREPARATION OF ASBESTOS FIBERS FOR EXPERIMENTAL USE

by

M. S. Badollet, Fairleigh Dickinson University, Madison, N. J., and
W. A. Gantt, State Department of Health, Trenton, N. J.

Asbestos in its natural state in the form of ore contains impurities associated with the ore body. These impurities may be part of the wall rock or occluded in or embedded in the crystal formation between layers of asbestos.

For fundamental investigations of biological effects of asbestos, it is essential to eliminate impurities that are not part of the asbestos molecule. To accomplish this, we have removed bundles of fibers from original unrefined ores, split them along the fiber planes with a knife into sections 1/16 to 1/32 inch thick, which were then cut with scissors into lengths of 1/8 inch or less, removing visible pieces of rock wall. This material was transferred to a Waring Blendor, a motor-driven rotating series of sharp blades in a vertical jar. The jar was half-filled with distilled water containing 2 to 3 grams of the hand-cut fibers. The Blendor was run until desired fiber length distributions were obtained. Samples with fiber lengths in ranges below 100 microns were thus prepared. The slurry was filtered through paper on a Buchner funnel, washed with water, alcohol and ether, then air dried. This preparation sharply decreased the hydrocarbon content of the material, as measured by estimation of several specific polycyclic hydrocarbons in a sample of amosite.

Some other methods for reduction of sizes are ball mills, fiberizers and disintegrators. The Blendor method has advantages which are two fold: it allows the operator to observe the grinding action, it can be stopped at intervals and samples quickly withdrawn for size measurement. Size is a function of time of grinding.

Fibers prepared by this method have been injected into hamsters and rats by Smith and Miller as reported elsewhere at this conference.

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SESSION 5, PAPER 4

TESTS FOR CARCINOGENICITY OF ASBESTOS

by

W. E. Smith and Thomas Miller
Fairleigh Dickinson University, Madison, N. J.

Asbestos samples were prepared from water slurries with a rotary knife according to a method described by Badollet and Gantt in a preceding paper at this conference. Soft chrysotile ore, harsh chrysotile ore, and a commercial sample of amosite were processed to average fiber lengths of 67, 36 and 19 microns, respectively. Single intrapleural injection was made into the right chest of golden Syrian hamsters (15 animals per sample). Each injection contained 25 mgms. of sample suspended in 0.5 cc. of 0.9% sodium chloride.

Extensive granulomatous and fibrous pleural adhesions resulted in each treatment group. Large intrathoracic tumors were found in 2 hamsters at 244 days and 356 days, respectively, after injection of commercial amosite, and in 2 other hamsters at 419 and 527 days after injection of harsh chrysotile No tumors have yet been found in hamsters given the sample of soft chrysotile. In each group, several animals are still living. The tumors showed local invasion and distant metastases. One was transplanted through 3 serial generations of new hosts in which it formed solid tumor masses up to 6 cm. in diameter.

In other experiments, 180 hamsters and 270 rats have been given weekly or biweekly intratracheal injections of four types of asbestos prepared by the rotary knife method (soft chrysotile, harsh chrysotile, amosite and crocidolite) in suspending medium (saline). Pneumonia and fibrosis but no tumors have been found in animals thus far examined. A majority of animals in these intratracheal tests are still living.

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TESTS FOR EFFECT OF ASBESTOS ON BENZO(a)PYRENE CARCINOGENESIS IN THE RESPIRATORY TRACT

by
Lloyas Miller and W. E. Smith
Fairleigh Dickinson University, Madison, N. J.

Studies by others associate asbestos with pulmonary carcinomas and pleural mesotheliomas in man. In a separate paper at this Conference, we reported pleural mesotheliomas in hamsters following intrapleural injection of harsh chrysotile or commercial amosite. Intratracheal injections or inhalation exposures with various types of asbestos have, however, thus far failed to elicit tumors in a variety of animal species. Experiments now reported were designed to test an hypothesis that asbestos may increase incidence of pulmonary carcinomas by promotion of action of some carcinogen to which man is peculiarly exposed through smoking.

Benzo(a) pyrene was selected as a type of carcinogen present in cigarette smoke. It was suspended in Tween 60 and administered to hamsters in weekly intratracheal injections to a total of 12.5 mgms. in 25 weeks with and without chrysotile. The test was started with 50 hamsters divided into 5 treatment groups of 10 animals each. Nineteen epidermoid carcinomas were found in the larynx, trachea and main bronchi. The first of these tumors was in an animal that died 173 days after start of test. Fourteen animals died, mostly from treatment accidents before that day. Remaining animals died or were sacrificed at intervals up to 214 days. In those examined between the 173rd and 214th day, four tumors were found in 3 of 5 hamsters treated with benzo(a)pyrene alone. Fifteen tumors were found in 7 of 7 hamsters treated with benzo(a)pyrene plus chrysotile. There were no tumors in 6 hamsters treated with chrysotile alone, in 8 treated with the suspending medium (Tween 60) or in 10 untreated controls.

A second experiment was done with weekly intratracheal injections of benzo(a)pyrene to a total of 8 mgms. with or without amosite. In 44 hamsters sacrificed 240 days after start of this test, gross examination revealed 11 tumors in 9 of 25 treated with benzo(a)pyrene alone and 6 tumors in 6 of 19 treated with benzo(a)pyrene plus amosite.

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SESSION 5, PAPER 6

ASBESTOS AND BRONCHIAL CARCINOMA

by
William D. Buchanan
Ministry of Labour, London, Great Britain

This paper describes the findings in a continuing study by Medical Branch of H.M. Factory Inspectorate, Ministry of Labour, of information recorded in death certificates of those dying with asbestosis.

By arrangement with the Registrar-Generals for England and Wales and for Scotland, copies of death certificates relating to certain causes of death are routinely sent to Medical Branch and from these the information has been obtained. It is believed that in Great Britain, a high proportion of asbestosis cases are recognized during life and that following death from whatever cause, this condition is then recorded on the death certificate, often after autopsy confirmation. Examination of the death certificates is considered to be a reasonably accurate means of determining the number of deaths from asbestosis and also any related pathology found at autopsy.

Earlier studies of this type were published in the Annual Report of the Chief Inspector of Factories for 1947, 1954 and 1955. These earlier studies indicated an apparent association between the presence of asbestosis and the finding of a thoracic tumour. Although such an association had been postulated some years before 1947, it is believed that the study reported in that year was the first occasion when this finding had been related to a sizeable group. The proportion so affected appeared to be increasing in the more recent studies.

Up to the end of 1963, 584 death certificates recording the presence of asbestosis have been thus obtained and the annual totals of such certificates are currently increasing. The proportion also recording a thoracic tumour has also in both sexes, continued to increase disproportionately to the total number so that currently over 50 per cent of males dying with asbestosis present have also a neoplasm. Even when viewed against the steadily rising incidence of lung cancer in the population as a whole, there seems little doubt that this increase is a real one.

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SESSION 5, PAPER 7

NEOPLASIA AMONG INSULATION WORKERS IN THE UNITED STATES WITH SPECIAL REFERENCE TO INTRA-ABDOMINAL NEOPLASIA

by
E. C. Hammond, I. J. Selikoff and J. Churg
The Mount Sinai Hospital, New York, N. Y.

This investigation has been concerned with 1,522 members of the New York metropolitan area Locals of the Asbestos Workers Union (I.A.H.F.I. & A.W., A.F.L.-C.I.O.) and has included every man who was a member of these locals on December 31, 1942 (632) or who joined to December 31, 1962 (590).

Detailed occupational and personal data were obtained from 1,117 men (of the 1,258 who were alive on January 1, 1963) who were examined. Union records were available for similar analysis for those men who were dead (264) or who failed to appear for examination (141). 43 men have died since the onset of the study.

We have previously demonstrated, using age-specific death rates in a prospective study of 255 consecutive deaths among this group of men 1943-1962, that total deaths were increased (observed 255, expected 204) as were deaths caused by cancer of lung and pleura (observed 45, expected 7) and stomach and colon (observed 29, expected 10).

We now report an analysis of the 307 consecutive deaths among these insulation workers January 1, 1943-August 30, 1964.

307 CONSECUTIVE DEATHS AMONG 1,522 ASBESTOS INSULATION WORKERS 1943-64

	(264) 1943-62		(43) 1963-64		TOTAL
Cancer of the lung	42		11		53
G.I. Cancer	30		5		35
Esophagus		1		0	
Stomach		11		2	
Colon-Rectum		18		3	
Mesothelioma, Pleura	3		1		4
Mesothelioma, peritoneum	2		3		5
Other neoplasms	20		7		27
Bladder		3		1	
Generalized		5		2	
Oro-pharynx		1		2	
Neck		3		0	
Pancreas		1		1	
Asbestosis	12		5		17
Pulmonary infection	7		0		7
Pulmonary tuberculosis	4		0		4
Cardiovascular	104		10		114
All other causes	40		1		41
	264		43		307

We have been particularly interested in analysis of those deaths due to intra-abdominal neoplasms (G.I. tract and peritoneum). For a variety of reasons, accuracy of diagnosis of such neoplasms is often insecure. In 2/5 of the 49 such deaths analysis of all available data showed the diagnosis to be presumptive only; this was especially true of stomach cancer (8 of 13) and generalized abdominal cancer (6 of 7). Therefore, it is possible that peritoneal mesothelioma may be even more common than the 5 of 307 deaths recorded.

In addition to the neoplasia among the recorded deaths, there are 3 men alive with known neoplasms (1 lung cancer, 1 pleural and 1 peritoneal mesothelioma) as well as one apparently cured of tongue cancer, one of cancer of the colon, and three following successful resection of localized lung cancer found in this survey.

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SESSION 5, PAPER 8

COHORT ANALYSIS OF CHANGES IN INCIDENCE OF BRONCHIAL CARCINOMA IN A TEXTILE ASBESTOS FACTORY

by

J. F. Knox, Turner Brothers Asbestos Co. Ltd., Rochdale, England, and
R. S. Doll, M.R.C. Statistical Research Unit, London, England

An association between asbestos dust inhalation and pulmonary fibrosis was first recorded in Great Britain at the turn of the century, but until further cases were reported 20 years later no official action was taken on prevention. A survey of the asbestos industry in Great Britain was carried out by members of the Factory Department of the Home Office in 1928-29 and a Report laid before Parliament in 1930. In a sample of 363 workers pulmonary fibrosis was found in greatest proportion in those employed for 20 years and upwards. These workers were principally employed in the asbestos textile industry.

Following the submission of this Report to Parliament Regulations were imposed in 1931 in order to reduce dust emission in manufacturing processes. Arrangements were also instituted for medical examinations of new entrants to the industry and periodic examinations thereafter. Workers found to be suffering from disability due to pulmonary fibrosis received compensation and might be suspended from further employment in the industry. Coroners were instructed to inquire into the causes of death of workers in the asbestos industry who had been suspended for disability or who were likely to have been affected by their employment. Necropsies were performed in most of these cases and material for study thereby accumulated. In a mortality study of the workers in one factory, excess mortality among workers employed for 20 years and upwards was observed. Lung cancer in association with asbestosis was responsible for a considerable proportion of this excess. A study of a group of workers from the same factory, exposed since the regulations, shows a reduction in mortality rate without excess of lung cancer.

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PULMONARY NEOPLASIA AMONG DRESDEN ASBESTOS WORKERS

by
G. Jacob, Krankenhaus Leninstrabe, Karl Marx Stadt, G.D.R., and
M. Anspach, Institute of Occupational Health, Dresden, G.D.R.

In the district of the "Silikoseerhebungsstelle Dresden" 2,645 persons (1124 women, 1521 men) who are or have been exposed to asbestos dust are at present under medical observation.

At present, 492 cases of asbestosis of varying degree are registered; in addition, 264 cases suspected of this disease are also under observation.

191 of those persons who were under medical control have died; in 121 cases the cause of death could be ascertained.

Among those persons ill of asbestosis, right-heart-failure was the main cause of death. Among asbestos workers only relatively few cases of lung cancer have been observed to the present.

A survey of the positively ascertained causes of death is given with special reference to neoplasia of the respiratory tract, the pleura, the peritoneum and tumors of other areas (gastro-intestinal tract a.o.).

The characteristics of lung cancer and the serosal tumors found in the Dresden autopsies are given. Data is given concerning the time of exposure to dust, latent period, sex, age, lung-lobe localization, histology a.o.

Comparison is made between lung cancer among the asbestos workers and that of the total population. Discrepancies between our data and that in other publications on the same subject are pointed out and considered.

Particular observations as to the question of the accumulated occurrences of pleura mesothelioma in the surroundings of the Dresden asbestos works are presented.

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SESSION 5, PAPER 10

THE RELATIONSHIP OF EXPOSURE TO ASBESTOS AND PLEURAL MALIGNANCY IN BELFAST

by
P. C. Elmes and O. L. Wade
Queen's University, Belfast, Northern Ireland

During the past 14 years 42 cases of pleural mesothelioma have been proved in Belfast derived from a total population of about 3/4 million. A positive history of exposure to asbestos at work was obtained in 32 of the cases compared with only 9 of 42 matched controls. Asbestos bodies were found in the lungs of 86% of patients with mesothelioma of the pleura, 20% of patients with carcinoma of the bronchus and in 20.5% of patients dying of non-malignant disease. The frequency of finding asbestos bodies in the lung is higher (27%) in men dying of non-malignant disease between 60 and 69 years of age who went into industry between 1905 and 1915 than in the 50-59 age group, who started work between 1915 and 1925. Between 1906 and 1923 over 1,000 tons a year of "boiler composition" was */ into Belfast compared with 600 tons a year at other times. Imports of other forms of asbestos containing materials (raw and manufactured) remained at between 50 and 200 tons until 1939 and since then has risen to over 1,700 tons per year in 1960.

There is no evidence of 'environmental' exposure from the industries using asbestos in Belfast but a positive history of exposure can only be obtained for three-quarters of the patients who die with asbestos fibres in the lungs. The latent period for the development of pleural malignancy after exposure may be up to 40 years so that increasing numbers of cases arising from exposure which has already occurred can be expected for many years to come.

*imported

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SESSION 5, PAPER 11

ASSOCIATION OF PULMONARY NEOPLASMS WITH ASBESTOS EXPOSURE IN NORTHERN ITALY

by
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G. Mottura, University of Turin, Turin, Italy, and
P. Maranzana, National Institute of Occupational Diseases, Lombardy, Italy

(Abstract not received)

SESSION 6, PAPER 1

EPIDEMIOLOGY OF DIFFUSE MESOTHELIAL TUMOURS: EVIDENCE OF AN ASSOCIATION FROM STUDIES IN SOUTH AFRICA AND THE UNITED KINGDOM

by
J. C. Wagner
M.R.C. Pneumoconiosis Research Unit, Glamorgan, Wales

An association between asbestosis and pulmonary malignancy is now generally accepted. More recent investigations have shown that there is an increased incidence of pleural and peritoneal mesotheliomas occurring in people occupationally or environmentally, exposed to asbestos dust. In some of these cases, the exposure has been extremely slight, and not sufficient to produce the histological features of asbestosis. The only pathological evidence of exposure has been the presence of asbestos bodies or fibres in the air spaces. In South Africa more than 100 cases of this tumour have been confirmed histologically. Nearly all these cases have been confined to one asbestos mining area. The majority of these people were not employed in the asbestos manufacturing industry. Chemical investigations have shown that oils containing carcinogenic hydrocarbons are present naturally in this particular type of asbestos.

At present, the incidence of diffuse mesotheliomas associated with exposure to asbestos dust is being investigated in Britain. Thoracic surgery units and pathology laboratories, who have records of these tumours, have been approached and an attempt is being made to find out how many of these cases have been exposed to asbestos dust. The investigation is only partly complete, and so far, as many cases have been discovered in Britain as were observed in South Africa. Details of these British investigations will be given in the papers that follow, and it will be seen that as in South Africa, the association is mainly between asbestos exposure and mesotheliomas, and asbestosis is often not a marked feature of these cases.

SESSION 6, PAPER 2

EPIDEMIOLOGY OF MESOTHELIAL TUMOURS IN THE LONDON AREA

by
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Two groups of patients who have attended a large hospital in the East End of London have been examined to determine their exposure to asbestos.

The first consisted of 83 patients in whom the diagnosis of mesothelioma had been confirmed at autopsy or by biopsy. In all but 7, past occupational and domestic histories were obtained. In 21 patients the tumour was peritoneal in origin, in 62 pleural. The earliest recorded death was 1917, but only 10 of the series died before 1950. 55% of the males and 42% of the females died under the age of 55. The interval between first exposure and development of terminal illness ranged between 16 and 55 years (mean 37 years).

The second group consisted of 76 patients of the same hospital, matched by sex and date of birth with those traced in the first series.

52.6% of those suffering from mesotheliomata had been exposed to asbestos, as compared to 11.8% of the control group. Three main types of exposure were recognized: work in factories manufacturing asbestos textiles, insulating materials and other products; employment as laggers or insulators, and exposure to dust brought home by relatives working with asbestos. 18 of those employed in factory work and four whose relatives were working with asbestos were employed at one factory. This factory opened in 1913 and was, until recent years, a heavy user of crocidolite; all those whose records could be traced worked with this type of asbestos.

Among the 36 patients with mesotheliomata, with no positive occupational history and no relatives living at home who worked with asbestos, there were 11 who lived within half a mile of an asbestos factory; 5 of the control series also lived in the same area. The difference in the proportion of patients in the two series is statistically significant.

SESSION 6, PAPER 3

CRITERIA FOR THE DIAGNOSIS OF DIFFUSE MESOTHELIAL TUMOURS

by
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Queen's University, Belfast, Northern Ireland

The criteria for the diagnosis of diffuse mesothelial tumour are at present imprecise and the security of the diagnosis often depends more on the degree of certainty with which metastatic tumour can be excluded than on any specific quality of the mesothelioma.

The gross appearances of the diffuse mesothelioma are not specific. It is uncommon, however, for metastatic carcinoma to duplicate the extensive sheet-like serosal infiltration which is especially characteristic of the diffuse pleural mesothelioma.

The diffuse mesothelioma shows remarkable structural variation histologically. The most specific structure is a mixed one resembling that of a carcinosarcoma. The commonly observed well differentiated tubulo-papillary or tubular pattern in which the cells are cuboidal or flattened is also unlikely to be confused with metastatic tumour. A form closely resembling that of a spindle-cell sarcoma is highly specific if the growth is known to be diffuse. Several other types of structure including the presence of clefts lined by tumour cells and the disposition of solitary spheroidal cells in the interstices of dense collagen are also thought to be highly distinctive. The diagnostic value of any of these patterns is greatly enhanced if they are associated with one another. It must be

SESSION 6, PAPER 3
(continued)

recognized that some otherwise acceptable mesotheliomas are histologically indistinguishable from other malignant growths.

If the diagnosis of diffuse mesothelioma is to be accepted without reservation two main criteria should be satisfied. 1. A thorough autopsy should have excluded alternative sources of tumour or have pinpointed any extra-serosal site where there is the least suspicion of a primary neoplasm. 2. The microscopic structure of the tumour should be consistent with a mesothelial derivation and permit certain differentiation from tumours arising in any tissue or organ which might have harboured a primary neoplasm grossly. Another less rigorous requirement is that the behaviour of the growth should conform within reasonable limits with that of previously proven examples and in particular show a clear-cut predilection to spread along the serosal membrane.

SESSION 6, PAPER 4

HISTOLOGICAL CHARACTERISTICS OF MESOTHELIOMA ASSOCIATED WITH ASBESTOS

by
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S. Rosen, Armed Forces Institute of Pathology, Washington, D. C.

(Abstract not received)

SESSION 6, PAPER 5

MESOTHELIAL TUMORS IN SOUTH AFRICA: PATHOLOGY AND EXPERIMENTAL PATHOLOGY

by
Ian Webster
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The pathology of tumours affecting the pleura and peritoneum in South Africa is described. One hundred and twenty-nine such tumors have been diagnosed as mesotheliomata and these cases are reviewed. Eighty-one of the tumors were diagnosed as suggestive of mesothelioma on the examination of a pleural biopsy specimen. These results as well as the exfoliative cytological findings are correlated with the final diagnosis of the patient.

The relationship of some of these tumors to pleural plaques is suggested.

The distribution of such tumors in the pathological specimens from two tuberculosis hospitals, thoracic surgical units and the Miners' Medical Bureau shows that the majority of the patients have been associated with the northern part of the Cape Province. The incidence of malignant tumors of the lungs in patients from the different asbestos areas of South Africa is given.

Animal experiments including those in which asbestos was inoculated intrapleurally are described. In a few of these, tumors resembling a mesothelioma have developed but such tumors have not been found in animals exposed to an asbestos dust cloud.

SESSION 6, PAPER 6

A BIOPSY SERIES OF MESOTHELIOMATA AND ATTEMPTS TO IDENTIFY ASBESTOS WITHIN SOME OF THE TUMOURS

by
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(Abstract not received)

SESSION 6, PAPER 7

PLEURAL MESOTHELIAL TUMOURS AND EXPOSURE TO ASBESTOS DUST

by
W. Glyn Owen
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An attempt to demonstrate association between asbestos exposure and diffuse mesothelioma was made by study of recorded samples of mesothelioma in the Merseyside area of North West England.

Thirty cases were considered. All had malignant disease of the pleura. Review of clinical histories and autopsy records was followed by reassessment of histological material. Diagnosis of mesothelioma was only accepted where histological appearances were thought to be characteristic.

Evidence of asbestos exposure was sought by microscopic examination of lung tissue for asbestos bodies and by occupational histories obtained from patients or their relatives.

Results: Seventeen cases were selected as true examples of diffuse mesothelioma (16 pleural, 1 peritoneal). Other diagnoses include secondary carcinoma (7), fibrosarcoma (3) and uncertain (3).

Evidence of asbestos exposure was obtained in 14 (82%) of the 17 mesothelioma cases. None of the other 13 patients was known to have handled asbestos.

Asbestos in Lung Tissue: Asbestos bodies were scanty in nearly all positive specimens. They were detected more easily in smears of lung juice. No asbestos bodies were seen within tumour tissue. Pulmonary fibrosis was minimal (no patient had been considered to have "pulmonary asbestosis").

Occupational Histories (17 mesothelioma cases): Of those giving history of asbestos exposure, 5 were laggers employed by firms of insulation engineers and 2 were boiler makers (ship-building). Two patients employed by sackware manufacturers handled old sacks which had contained asbestos. Only 2 patients had worked in asbestos factories. One patient gave history of close environmental exposure, having worked in the offices of concrete manufacturers using asbestos cement.

Five gave inconclusive histories. Asbestos bodies were present in the lungs of two of these. Each of the other 3 patients had worked in places where they may have handled asbestos but there was no direct evidence (1 boiler maker, 1 ship repairers' apprentice, 1 dock railway labourer).

General Information: Sixteen out of 17 mesothelioma patients have died. Average age was 58 years. There were 12 men and 5 women. Length of exposure ranged from 5 to 43 years. Shortest interval from first exposure to development of tumour was 13 years. Interval from end of exposure to development of tumour from a few months to 40 years.

No attempt was made to ascertain types of asbestos fibre used and no approach was made to industrial firms or other employers.

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SESSION 7, PAPER 1

TRENDS IN THE HEALTH OF THE ASBESTOS WORKER

by
Kenneth W. Smith
Johns-Manville Corporation, Manville, N. J.

What is an "asbestos worker"? An attempt is made to define the type of work which would properly classify an asbestos worker. Exposure to multiple toxic dusts is discussed.

There are three main types of asbestos fibers in commercial use today. They are different physically and chemically, and produce disease entities which are different chemically and radiologically. Workers in many parts of the world are exposed to one or another type of asbestos fiber. Should the health experience of a group using only chrysotile be compared with that of a group using only amosite or crocidolite?

The importance of the geographical location of the asbestos deposit is important. Are other factors such as chrome, nickel, radioactivity, etc., associated with some deposits and not others important?

Population characteristics are discussed. Disease incidence in a stable, isolated population is compared with that of an urban floating population.

The association of other diseases with the presence of the asbestos fiber is discussed. Should there be an association of a particular disease with the asbestos fiber when there is no asbestotic fibrosis present?

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SESSION 7, PAPER 2

PROBLEMS AND PERSPECTIVES: THE SEQUELAE OF EXPOSURE TO ASBESTOS DUST

by
J. C. Wagner
Pneumoconiosis Research Unit, Glamorgan, Wales

The sequelae of exposure to asbestos dust include the inhalation of the fibres, their deposition and the results of their subsequent retention. During this conference a number of these factors have been clarified, and those problems most urgently requiring investigation defined. In this paper some of the salient features are summarized and certain facets illustrated, and aspects in need of further investigation emphasized.

Logical explanations have been given for the presence of long asbestos fibres in the smaller air spaces. Experimental evidence has been given to show that there is a difference in the retention of various types of asbestos. The formation of the asbestos body has been described and the significance of these bodies and fibres in sputum assessed. The anatomical site at which the lesions of asbestosis originate has been defined and the progression of the disease demonstrated in experimental animals. The variation of the effect of different forms of asbestos fibre is most clearly illustrated in the monkey and the rabbit. The previous concepts of the significant particle size, and the solubility of the respirable dust, have been seriously challenged. However, the exact mechanisms of the pathogenesis of the disease is still unknown and the migration of asbestos fibres including the ultramicroscopic from the respiratory tract requires much further study.

The malignant neoplasms associated with exposure to asbestos dust have been discussed. On current evidence, the earlier view that carcinomata of the lung occur in cases with a significant degree of asbestosis is fully supported, but information is still required to confirm that there is no correlation between exposure per se and these tumours. More information is needed on the association of these tumours with different types of fibre. Mesotheliomas of the pleura and peritoneum seem

SESSION 7, PAPER 2
(continued)

to be associated with exposure to crocidolite dust, however there are some cases of these tumours in which there is evidence to suggest the implication of chrysotile and anthophyllite. Therefore, there is a real need for comparative surveys in all the asbestos producing areas. In addition, a suggestion has been made that tumours of the gastro-intestinal tract may be a further sequela of asbestos dust exposure and evidence of this, and other malignancies, should be sought.

Intra-pleural inoculations in experimental animals have shown that crocidolite, amosite, chrysotile and even silica, can produce pleural mesotheliomas. The high incidence in these experimental conditions can be explained in part by the site of deposition and the high dosage used. The significance in these tumours of the oils naturally adsorbed onto the crocidolite fibres is being assessed. It has become obvious that in this work, and in the investigation of the biological effects of asbestos itself, there is a need for a joint effort by the experimental biologist, mineralogist, and chemist.

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SESSION 7, PAPER 3

PROBLEMS AND PERSPECTIVES: THE CHANGING HAZARDS OF EXPOSURE TO ASBESTOS DUST

by
J. C. Gilson
M.R.C. Pneumoconiosis Research Unit, Glamorgan, Wales

When Montague Murray first suggested that heavy exposure to asbestos dust could produce fatal pulmonary fibrosis, no one could have predicted that the diversity of its effects in man would be so great as to justify some 60 years later a whole conference devoted to the subject.

The changing pattern of hazards of exposure to asbestos dust has features in common with other industrial diseases. Great improvements in one area - the result of vigorous control action by engineers - proceeding simultaneously with an extension of the hazards elsewhere as new uses of the material are discovered. The hazards of fibrosis for the asbestos textile worker appear to be much less but the insulation workers are often not adequately protected. Do other groups of workers exposed in the newer uses of the material need closer inspection?

The prognosis, once a definite diagnosis of asbestosis has been made, is poor. Can newer methods of functional analysis of the lungs provide the means of detecting abnormality in the individual or even in the group, so that action can be taken in time to prevent further damage before a progressive disease has been established? There is a most striking contrast between the detailed quantitative knowledge now available about the natural history of coalworkers' pneumoconiosis which can be used in prevention and the absence of such information in asbestosis. Will prospective studies of asbestos workers be established to remedy this?

The striking feature of this conference is the new evidence showing that not only is there a high risk of bronchial carcinoma in those with asbestosis but that other types of tumour occur in the lungs and elsewhere in those exposed to the dust, and that these tumours develop in the absence of asbestosis in the lungs and sometimes after a small exposure but always with a long or very long delay. The evidence in man indicates that the type of fibre to which the individual is exposed - a long neglected aspect of this whole problem - is of great importance in the development of these tumours.

The changing pattern of hazard can be summarized thus. In the early days men working in uncontrolled conditions developed asbestosis within a few years and died young often of its complications, pneumonia or tuberculosis. As factory conditions altered and the control and treatment of tuberculosis and pneumonia improved, the onset of the disease was delayed and the late effects of fibrosis, such as bronchiectasis, bronchitis and cor pulmonale were more common. Still more recently the workers who have developed only moderate degrees of asbestosis have survived long enough to develop the associated bronchial carcinoma. In addition, and unexpectedly, we are at this time seeing the late effects of exposure to certain types of asbestos (occasionally only environmental) which were insufficient to produce appreciable lung fibrosis but have after a delay of 40 or more years led to mesothelial tumours in the pleura and elsewhere.

These cases date from the time when the industry was a small fraction of its present size, and their discovery emphasizes the need to eliminate all unnecessary exposure to asbestos dust in the future. But even if this was achieved at once we may anticipate an increased incidence of tumours from exposures during World War II, when dust control was inevitably less good.

There is an urgent need to measure quantitatively the magnitude of the risk for different types of fibre so that if the risk is very different, as appears probable, the safest material can be used in the future.

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SESSION 7, PAPER 4

MULTIPLE FACTORS IN RELATION TO NEOPLASIA AMONG ASBESTOS WORKERS

by
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(Abstract not received)

NOTES ON PREPARATION OF MANUSCRIPTS

The Academy's Editorial Division has already mailed out notices to the senior authors listed in the program for this conference informing them of the deadline for the submission of manuscripts to be published in the conference monograph; senior authors who did not receive such a notice, or who will have problems meeting the announced deadline, are asked to contact the Editor at the Academy building. Included with this advance notice were a set of Instructions to Authors and a special announcement regarding size of manuscripts and extra charges to authors. It may be helpful, however, to bring out at this time the following points regarding the preparation of manuscripts:

Manuscripts. Manuscripts should be typewritten on white bond paper, double spaced throughout - - including references, Figure captions, footnotes, etc. Submit only the original copy.

References. All references listed must be cited in the text. References can be set up either numerically or alphabetically (see the Academy's Instructions to Authors for further details). If the numerical system is used, references must be cited in the text in ascending numerical order, reference # 1 being the first reference cited, etc.

Art Work. If possible, please avoid submitting over-sized tables or illustrations. For example, photographs (or other artwork) that are considerably larger than the usual 8" x 11" size must be so drastically reduced to fit our page size as to often eliminate a good deal of detail. Remember too that words, numbers or letters within any Figure illustration should be large enough so that if reduction is necessary, such words, numbers or letters will still be legible.

Note to Foreign Authors. All material, except references to foreign publications, must be in English. This requirement includes table titles and column headings and any interior information within a Figure illustration.

Authors who at any time have any questions regarding the preparation of their manuscripts should feel free to contact the Editor at the Academy.