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The Status of Byssinosis in the United States

A Summary of the National Conference on Cotton Dust and Health and the Recommendations of the Organizing Committee

THE National Conference on Cotton Dust and Health was held at Charlotte, NC, on May 2, 1970, to assess the health problems of cotton dust exposure. The participants included 200 scientists and representatives of industry, textile unions, state and federal government agencies, and private medical practice.

Byssinosis is a recognized occupational respiratory disease which has been studied extensively in many countries. However, until recently little knowledge of this disease existed in the textile industry and the medical profession in the United States. The conference was planned as an educational activity to enlist the talents of the agricultural, manufacturing, engineering, and medical communities of our society to control and prevent this disease.

Session 1: Medical Aspects of Byssinosis

Richard S. Schilling MD, DSc, of London and Arend Bouhuys, MD, PhD, of Yale University discussed medical aspects of cotton dust exposure. Byssinosis occurs throughout the world and affects cotton, flax, and soft hemp workers. Epidemiological studies of respiratory disease among textile workers date from 1845, when Monday chest tightness, characteristic of byssinosis, was first described. That until recently it has not been more widely recognized as a significant problem is due to the failure to ask relevant questions. These concern occupational exposure and Monday symptoms, irregular work periods which may obscure typical Monday symptoms, and, in the later stages of byssinosis, the presence of continuous dyspnea and chest tightness which do not change throughout the week. Between 1910 and 1932, elevated morbidity and mortality rates were found among those exposed to high dust levels in British mills. Although those working in the preparation areas are at greatest risk, those working in later processes, such as winding, may develop the disease.

Dr. Bouhuys reviewed three recent US surveys which showed that 25% to 30% of workers in the carding area had byssinosis. Reactors to byssinosis can be identified by a decrement in expiratory flow rate following exposure to cotton dust, and this is a useful tool for epidemiological surveys and surveillance. Studies quantifying disability and mortality from dust exposure are lacking in the United States. However, a community of hemp workers in Spain was shown to have disability associated with long-term exposure. It was stressed that the acute symptoms of byssinosis, Monday chest tightness and dyspnea, may occur in some individuals within weeks of initial exposure. Workers

identified in this way should be monitored and removed from dusty areas before permanent pulmonary dysfunction occurs. Present knowledge has not been applied to prevent workers from becoming disabled by byssinosis and certain other industrial lung diseases.

Session 2: Cotton Dust Sampling

Byssinosis can be prevented by reducing workers' exposure to airborne dust. The present threshold limit value (TLV) for cotton dust of 1.0 mg cu m of air is based on British findings in 1960. Exposure to total airborne particles below this TLV was associated with less than 5% byssinosis. In these earlier studies, the best correlation was found between byssinosis and medium-sized particles with a high protein content. However, levels of fine respirable dust (less than 15 micrometers) appear to correlate best with symptoms in more recent studies. Differences in air sampling techniques and in diagnostic grading of byssinosis have made it difficult to compare investigations and probably account for some of the disparities in prevalence and dust levels.

The agent (or agents) which causes byssinosis has not been identified, but its proportion in dust may vary considerably. Therefore, if dust levels are reduced to the TLV, workers may still be at risk. This fact, as well as wide variations in individual susceptibility, makes medical supervision of employees necessary. It is recommended that:

1. The measured exposure of employees should be correlated with medical findings in epidemiological studies for the purpose of establishing exposure standards.
2. The method developed should be suitable for use by regulatory agencies and others to determine compliance with the standard.
3. It should be usable for the evaluation of the effectiveness of dust control measures that may be developed for plant use.

The sampling method should measure the particle size range that is thought to be of pathological significance. Because cotton fibers do not cause byssinosis, all fibers should be excluded from the sample. Vertical elutriation appears promising for lint-free sampling and affords some flexiblity in the particle size collected.

Session 3: Dust and Lint Suppression

Initial efforts to clean the atmosphere in cotton manufacturing plants were aimed at removal of lint, fly, and other visible particulate matter. After 1945, air washers, added to plant ventilation systems, removed much of the cotton lint. Installation of paper or nonwoven fiber filters ahead of the air washer removed most large particles and relieved the overload of solids in the wash water. A rotating drum filter using a nonwoven polyester fiber medium is a common prefilter. Efficiency is improved by positioning the intake air vents nearer the sources of lint generation.

Because carding machines are major sources of dust and lint, particularly when operated at high speeds, local exhaust ventilation systems have been applied to the cards. These systems usually have slotted hoods located at the major lint-producing points of the carding machine that pick up the lint and fly and transport it to a bag-type collector or the plant air cleaning system. Vacuum stripping and fly removal at carding machines also decrease the intermittent high total atmospheric dust levels when these operations are performed. However, there is evidence that little of the fine dust is removed.

Frame cleaners are combination vacuum and blower units that continuously transverse the length of spinning frames on overhead tracks. They are primarily designed to blow away accumulations of lint in the drafting zone that may effect the quality of the yarn spun. Some lint is removed from the floor by the vacuum side of the blower on these cleaners, but this does not improve workroom air.

Session 4: Management's Responsibility to People

Gordon Hanes, chairman of the board of Hanes Corporation, reviewed this topic from the era of the mill store and the mill town with virtual "enslavement" of the employee to more enlightened management which is concerned with providing insurance protection and a safe atmosphere in which to work. He stated that Ralph Nader had done

the industry a service by calling national attention to the problem of byssinosis. A number of individual mills have already participated in investigations of byssinosis and noise pollution. He concluded that industry has a very large responsibility that is "more widely recognized and is being more effectively acted upon today than it has ever been before."

Session 5: Foreign and US Investigations

Investigators from Australia, Egypt, Poland, Yugoslavia, and the United States summarized studies of byssinosis as an occupational disease with sociological and economic implications. Bryan Gandevia (Australia) observed that a disease does not exist in an industry but rather in a society. Social and economic factors influence the worker's exposure to dust, including the opportunity for the susceptible worker to elect not to work in an environment detrimental to his health. Summaries of proposed cross-sectional studies by the Industrial Hygiene Foundation and Duke University-North Carolina State Board of Health were presented. These investigations will determine the prevalence of byssinosis and will assist in formulating a realistic TLV for cotton dust based on respirable particles. Questions urgently needing investigation include (1) how can respirable dust be removed from cotton prior to the manufacturing process, and (2) how effectively and economically can exhaust ventilation and improved filtration reduce dust levels? Population studies to determine disability and mortality rates among those with high dust exposure were called for. Professor Irving Selikoff (New York) summarized by listing priorities concerning byssinosis in order of increasing importance: medical research which is and will be done without encouragement, industry-wide planning and applications of resources, development of appropriate medical and engineering surveillance, care for the partially or totally disabled workman, cooperation among engineering, medicine, industry, and labor to develop solutions, and, finally, adequate immediate control of dust.

Recommendations on Byssinosis.

Dust Sampling and Control.—A respirable dust level at which not more than 5% of exposed workers develop symptoms or have a decrease in forced expiratory volume in one second ($FEV_{1.0}$) must replace the present TLV of 1 mg/cu m of total lint and dust. The vertical elutriator which samples particles with an aerodynamic diameter below 15 micrometers appears to be a simple and reproducible sampling technique. Vertical elutriators devised by Lynch and Lumsden are being used during current prevalence studies to provide essential comparisons between levels of respirable dust and symptoms of byssinosis and decreases in $FEV_{1.0}$ during exposure. Until such standards can be achieved, it is recommended that:

1. Dust control should be applied to every cotton gin and those textile mills working with raw cotton. All machinery in opening, blending, picking, and carding should have the maximal enclosure consistent with the process and be provided with local exhaust ventilation adequate to keep dust concentrations inhaled by workers below recommended limits.

2. General ventilation of all operations subsequent to carding sufficient to keep inhalable dust concentrations below recommended values should be provided. All recirculated air should be filtered, with no more than 0.05 mg/cu m of particulate matter in the return air.

3. Lint-free inhalable dust concentrations of a size below 15 micrometers, aerodynamic diameter, should be measured periodically in all mills processing raw cotton, using sampling devices such as the vertical elutriator cotton dust sampler.

Identification of Reactors.—Schilling's grading system based on symptoms is the standard method for classifying byssinosis.

Grade 0—No evidence of Monday chest tightness or breathing difficulty.

Grade ½—Occasional chest tightness on the first day of the working week.

Grade 1—Chest tightness on *every* first day of the working week.

Grade 2—Chest tightness every first and other days of the working week.

Grade 3—Grade 2 symptoms accompanied by evidence of permanent incapacity from diminised effort intolerance and/or reduced ventilatory capacity.

Recommendations for Classification and Management

Functional Severity	$FEV_{1.0}$* (% of Predicted)	$\Delta FEV_{1.0}$† (%)	Interpretation of $FEV_{1.0}$	Recommendations for Employment
F_0	>80 (no evidence of chronic ventilatory impairment)	−4 to 0; or +	Minimal or no acute effect of dust on ventilatory capacity	No change; annual $FEV_{1.0}$
		−9 to −5	Moderate acute effect of dust on ventilatory capacity	No change; 6-mo $FEV_{1.0}$
		−10+	Definite and marked acute effect of dust on ventilatory capacity	Move to lower risk area; 6-mo $FEV_{1.0}$
F_1	60-79 (evidence of slight to moderate irreversible impairment of ventilatory capacity)	−4 to 0; or +	As above	No change; 6-mo $FEV_{1.0}$
		−5+	As above	Move to lower risk area; 6-mo $FEV_{1.0}$
F_2	<60 (evidence of moderate to severe irreversible impairment of ventilatory capacity)	...	...	Work requiring no cotton dust exposure; detailed pulmonary examination

* $FEV_{1.0}$ in the absence of dust exposure (two days or longer).
† Difference between $FEV_{1.0}$ before and after six or more hours of cotton dust exposure on a first working day.

Skin tests and chest x-ray films do not identify reactors. Serological tests will not differentiate the exposed nonreactor from the exposed reactor. Inhalation challenges with aqueous extracts of cotton dust may establish an individual's sensitivity. However, the lack of a chemically defined test material and the nonspecific effect of aerosols invalidate the use of challenge testing as a diagnostic measure. In contrast, most persons with chest tightness show a decrement in expiratory flow rates after six hours of dust exposure following two or more days without exposure. Flow measured at 50% of vital capacity is sensitive to small changes. However, $FEV_{1.0}$ has been measured in most studies of byssinosis. Measurement of $FEV_{1.0}$ and forced vital capacity (FVC) before and after six hours of exposure, to determine whether exposure caused a decrease, should be included in surveys for byssinosis. The initial $FEV_{1.0}$ provides a baseline measurement to categorize ventilatory capacity, and the presence of a decrease after exposure identifies reactors. A functional grading scheme based on that proposed by Bouhuys is recommended for assessment and management of the exposed worker. At least four forced expirations should be obtained and the two best $FEV_{1.0}$ values averaged for each observation (Table).

Most individuals with grade 1, 2, and 3 byssinosis have a moderate to marked decrease of $FEV_{1.0}$ after six hours of dust exposure. However, evidence of no decrement in $FEV_{1.0}$ does not preclude the diagnosis of byssinosis in persons with symptoms. Asymptomatic individuals who have a reproducible decrememt in $FEV_{1.0}$ of 10% or more should be managed as if they have byssinosis. All individuals with byssinosis must stop smoking cigarettes, particularly if they remain in a dusty area.

Medical Surveillance and Management.— Every prospective employee in a textile plant spinning cotton yarn should complete a modified British Medical Research Council respiratory questionnaire, adapted for byssinosis, to assess chronic bronchitis, byssinosis, dyspnea, smoking history, and occupational history, plus a baseline $FEV_{1.0}$ and FVC.

1. Prospective employees with recurrent or chronic respiratory disorders or grade 2+ dyspnea and moderate to heavy cigarette smokers should be placed in low- or no-risk areas. If that is not possible, they should be advised to work elsewhere.

2. Those with an $FEV_{1.0}$ observed-$FEV_{1.0}$ predicted ratio between 60% to 79% should be placed in a low- to no-risk area and those with a ratio below 60% should not be exposed to any cotton dust.

3. Within a month of employment, an

$FEV_{1.0}$ before and after six hours of exposure on the first working day of a week should be obtained and the worker reassigned if necessary.

4. Workers exposed to high levels of dust, ie, dust house and stripping and grinding cards, should use efficient, comfortable, personal air-filtering respirators or self-contained air supplies.

5. Workers with grade 3 byssinosis (those with pulmonary disability) should have detailed evaluations. A minimal work-up should include a detailed clinical, environmental, and occupational history with information about the plants in which he has been employed and his acute response to exposure. Also, a posteroanterior and lateral chest x-ray film, measurement of FVC and $FEV_{1.0}$ and values for arterial blood gases at rest and during steady-state exercise (treadmill walking) should be obtained. In addition, other tests for uniformity of ventilation and air and gas transfer may be helpful.

6. These results should be used in the compensation process as dictated by state and/or federal laws.

Priorities for Investigation

1. A TLV for respirable cotton dust ($< 15\mu$) must be established and a simple practical and reliable sampling device perfected.

2. Exhaust ventilation and better filtration systems should be designed to remove respirable dust and installed to provide a safe working environment.

3. The most economic and effective technique to remove respirable dust from cotton prior to manufacturing should be found by examining the plant, methods of harvesting, methods of ginning, and other processing methods for cotton before it reaches the textile mill.

4. The prevalence of byssinosis should be determined in ginning and delinting industries.

5. Disability and mortality rates among US cotton textile workers must be determined from population and life table studies.

6. The pathogenesis of byssinosis should be studied with the participation of cotton agriculturists, geneticists, and medical research teams, aiming at eliminating the offending agent from the cotton plant.

The organizing committee included Howard E. Ayer, MS, Mario Battigelli, MD, David A. Fraser, ScD, John D. Hamilton, MD, Kaye H. Kilburn, MD, John Lumsden, Jeremiah R. Lynch, James A. Merchant, MD, and Alan D. Stevens, DVM.

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