Pulmonary function Tests

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PULMONARY FUNCTION TESTS FOR POSSIBLE IN-PLANT USE

The following proposed tests are designed to give information relating to pulmonary function of workers under actual industrial conditions. Their use could be either as a spot check among workers exposed to possible airborne pollutants, or preferably as a periodic survey of all workers every year or two, for the purpose of detecting minimal damage to the lungs or even incipient lung disease of a nonindustrial type. If eventually used for survey purposes, they will have to be standardized and simplified so that plant physicians and nurses can carry most of them out under supervision; analysis of the results would be done at Haskell.

Under each test will be listed the equipment required for the test. As will be apparent, some require more complicated apparatus than others. In many cases, once the transducers and recorders were set up, the same equipment could be used for all the tests.

I. Timed Vital Capacity

This test requires cooperation and tests muscle strength and lung mechanics. The total vital capacity gives a measure of lung and chest elasticity, while the rate of expulsion of the air depends on lung gas-flow resistance, primarily. Because of the muscle factor, this test is only moderately sensitive, but its simplicity is its chief virtue. Equipment needed: Spirometer and timing device.

II. Maximally Rapid Expiration with a Pneumotachograph

Requires cooperation. The information obtained in this test is similar to that obtained with a timed vital capacity. The advantages are (1) lung compartments can be obtained with one breath, (2) the expiration flow pattern is less dependent on muscle strength and gives a better picture of the degree of "check-valving" present as a cause for slowing of expiration. Equipment needed: Pneumotachograph and transducer with a recorder.

Lung studies

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DUP-258

III. Maximum Breathing Capacity

Requires cooperation and tests muscle strength as well as lung and chest resistance. Useful chiefly because it permits comparison with other groups studying pulmonary function. Equipment needed: Low resistance valve and bag for collection. Can also be done with a pneumotachograph, which has some advantages (i.e. lower mechanical impedance).

IV. Relaxation - pressure-volume curves

Requires very great degree of cooperation. Equipment needed: Spirometer, three-way valve and mercury manometer. The requirement of subject training is so great that this test is considered impractical and is not recommended.

V. Lung Mechanics During Quiet Breathing

These studies require no cooperation after passing of the esophageal balloon. Equipment needed: Pneumotachograph and transducer-recorder, esophageal balloon and pressure recorder. This test requires a considerable amount of equipment, but it is minimal if a more detailed analysis of lung mechanics is desired. These studies are very sensitive and would indicate very transient or minimal effects which would be missed by the above tests.

VI. Lung Mechanics During a Slow Deep Breath

Similar to above with respect to equipment. Tests somewhat different properties of lungs.

VII. Lung Mechanics at Varying Breathing Frequencies

Equipment similar to V and VI above. Requires a small amount of cooperation. Tests uniformity of mechanical properties throughout lungs, and should be a very sensitive index of early emphysema, bronchospasm, or increased bronchial secretions.

VIII. Nitrogen Washout Curves

Requires some cooperation. Tests dead space and mixing of gases in lungs, and is gas exchange counterpart of VII. Widely used now in assessment of emphysema. Equipment needed: Pneumotachograph or spirometer and rapid nitrogen analyser.

IX. Carbon Monoxide Diffusing Capacity

Requires cooperation of subject. Equipment needed: CO analyser, preferably rapidly recording, and a pneumotachograph or spirometer. The functional significance of this test is not completely established, and for this reason (plus the fact additional equipment would be required) this test is not recommended at the present time.

X. Ventilatory Response to Exercise

Requires no cooperation. Equipment needed: Strain-gauge type of recorder with a pneumograph. Some development work will be needed to determine the positioning of the pneumograph, but this study would be intended to apply where the men worked.

XI. Ventilatory Response to Increased Inspired O_2

Equipment needed: Spirometer containing oxygen mixture. This test requires no cooperation and would test the degree of arterial desaturation which is present.

XII. Ventilatory Response to 5-7 Per Cent CO_2

Equipment needed same as XI above. Tests for abnormalities of the resting arterial pCO_2. Note: These last two tests are "chemical" tests of the gas concentrations of the arterial blood. They are simple and require minimal time to perform.

The battery of tests proposed initially would be more elaborate than is probably necessary, and as experience with them under plant conditions accumulated, some could no doubt be eliminated.

Briefly summarizing, the tests are of two main types, those requiring a minimal amount of training for the supervisor, and those carried out by trained Haskell personnel. In the first group are tests I, III, X, XI and XII. In the second are II, V, VI, VII, and VIII. The chief reason for the greater training required for these tests is because of the more complicated equipment required, but it should be emphasized that these tests are much more sensitive and can be interpreted more directly in terms of lung changes. The equipment for all of the more complex tests is already available or is forecast, except for a two-channel portable recorder-amplifier. An initial survey could be begun within three to six months. In view of the contrast with the East Chicago Plant already on hand, this would be a good plant to begin, but it would be my hope that once the techniques are set up and a survey has been done, other plants where dusts or fumes are a problem could be interested in a spot check or serial studies of this type.

KPH/dyb
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