

CHANGES IN FORCED EXPIRATORY VOLUMES THROUGHOUT THE DAY

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The early-morning exacerbation of their symptoms is often the bitterest complaint of patients suffering from chronic productive cough and breathlessness. The important immediate cause of this chronic breathlessness is probably persistent airway obstruction. An increase in the severity of this obstruction may cause the early-morning increase in breathlessness. This study was undertaken to show the magnitude of the change in the airways, and to find out whether it is peculiar to obstructive airway disease or whether it is part of a cycle of changes throughout the day present both in health and in airway disease.

Methods and Results

Five healthy men (mean age 30 years; mean forced expiratory volume 3,270 ml.) and 16 male patients with obstructive airway disease, 12 severely affected (mean age 57 years; mean forced expiratory volume 760 ml.), and four mildly affected (mean age 48 years; mean forced expiratory volume 2,190 ml.) were tested. In each patient the diagnosis of chronic bronchitis and emphysema, with or without asthma, had been made. The patients were admitted to hospital for 48 hours, usually at the week-end to avoid loss of work if the patient was working.

Two measurements were made with a recording spirometer—the volume of air expelled during the first

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second and that expelled during the completion of a forced expiration following a full inspiration. These are, respectively, the forced expiratory volume (F.E.V.) and the forced vital capacity (F.V.C.). These were recorded at fixed times during the day, including 10 p.m. and 6 a.m. No medicines were taken.

The results in each case and the mean of the results of each group are shown graphically in Figs. 1, 2, and 3.

At 6 a.m. the F.E.V. and the F.V.C. were lower than at any other time of the day both in healthy subjects and in patients. By 8 a.m. the mean increase in the F.E.V. was 2.9% in the healthy subjects. By 9 a.m. it was 60% and 36% respectively in the patients with mild and with severe obstructive airway disease. Similar changes were seen in the F.V.C.

Relatively large spontaneous variations in the F.E.V. and the F.V.C. occurred between 9 a.m. and 5 p.m. in the patients.

Discussion

The changes in the F.E.V. and the F.V.C. probably reflect changes in the severity of airway obstruction and

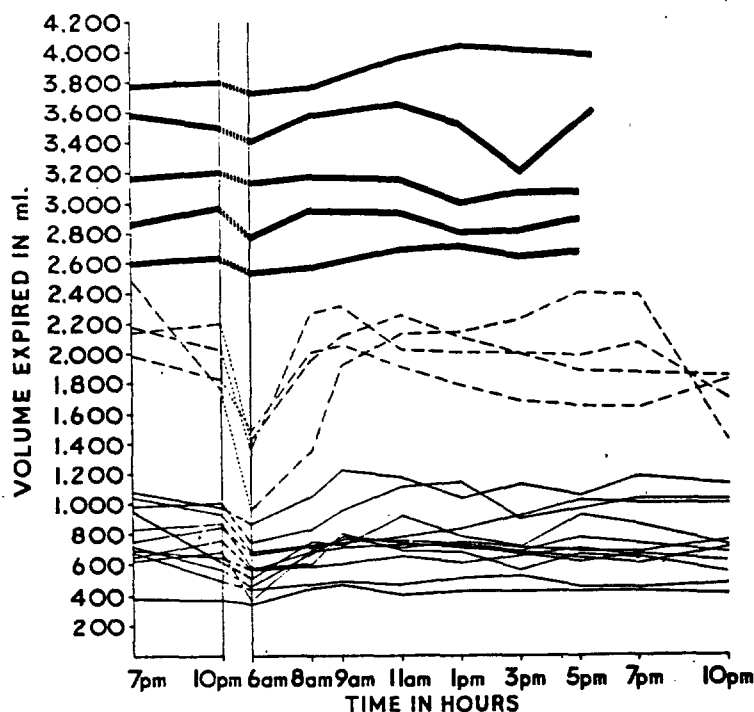


FIG. 1.—Changes in the F.E.V. during the day in normal, mildly affected, and severely affected subjects. —: Normal. ----: Mild.: Severe.

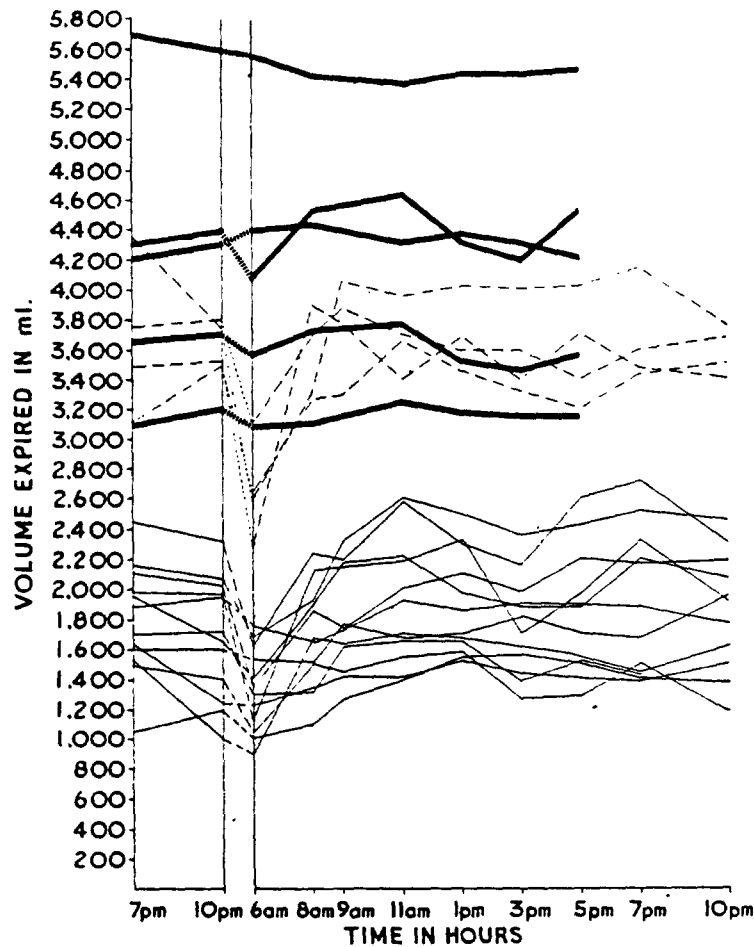


FIG. 2.—Changes in the F.V.C. during the day in normal, mildly affected, and severely affected subjects. —: Normal. ----: Mild. —: Severe.

possibly changes in total lung capacity as well. Total lung capacity may fall because of an increase in the volume of blood in the lungs or a decrease in the number of patent alveoli occurring during sleep. Alterations in expiratory force are probably of minor importance; a greater expiratory force which might increase the F.E.V. would reduce the F.V.C. (the vital capacity of patients with obstructive airway disease is greater when expelled without force). In fact, the F.E.V. and the F.V.C. varied together. Failure to inspire to maximum depth would reduce both the F.E.V. and the F.V.C. This was prevented so far as possible by carefully briefing the subjects.

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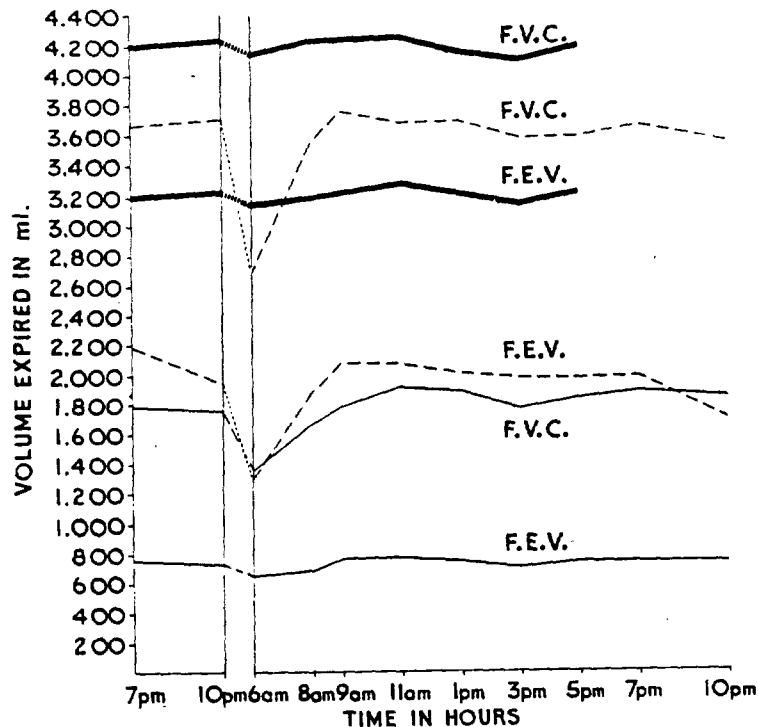


FIG. 3.—Changes in the mean F.E.V. and the mean F.V.C. during the day in normal, mildly affected, and severely affected subjects. —: Normal. ----: Mild. —: Severe.

Between 10 p.m. and 9 a.m. the pattern of change was the same for each subject—a marked dip and rise of the F.E.V. and the F.V.C. Not all patients expectorated in the morning. In those who did, improvement in spirometry was not related to the volume or character of the sputum, but often followed expectoration immediately.

Between 9 a.m. and 10 p.m. the pattern of change was different in each subject. The F.E.V. of the mildly disabled patients and the F.V.C. of some of the severely disabled patients varied in a regular manner. Other changes appeared random (Figs. 1 and 2). A number of patients showed a distinct fall in the F.V.C. after the midday meal.

These changes were recorded during a day spent in hospital. McKerrow *et al.* (1958) have shown that the F.E.V. of cotton-workers falls during their day in the dust of the mill. In contrast, coal-miners slightly increased their F.E.V. during the shift at the coal-face. These investigators also give experimental evidence for

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the relationship between the F.E.V. and airway resistance.

Patients shown by spirometry to have severe airway disease may be but moderately disabled by effort breathlessness. A comparatively small increase in the airway obstruction may then cause severe disability (Capel and Smart, 1959). Such an increase occurs during sleep. The severity of the morning breathlessness may therefore reflect the magnitude of the permanent airway obstruction rather than the magnitude of the morning deterioration alone.

Conclusion

Relatively large spontaneous variations in the F.E.V. and the F.V.C. of patients with obstructive airway disease may occur between 9 a.m. and 5 p.m. This might affect the interpretation of results when serial changes in these volumes are used to measure the action of drugs on the bronchial tree.

The early-morning decrease in the F.E.V. and the F.V.C. was found to be part of a cycle of changes occurring throughout the day both in health and in generalized obstructive airway disease. The decrease was greater in patients with airway disease. The severity of the resulting increase in breathlessness probably reflects the magnitude of permanent obstructive airway disease rather than the magnitude of the temporary decrease in the F.E.V. and the F.V.C.

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