LETTER TO THE EDITOR

MEAN EXPIRATORY FLOW VOLUME CURVE

(Received on September 3, 1980)

Sir,

During the performance of a Forced Vital Capacity (FVC) manoeuvre, the flow rates decline with lung volumes, but the extent of reduction of flow with volume is not readily evident in an FVC tracing which is a volume-time curve. The Maximal Expiratory Flow-Volume Curve which developed from the work of Fry and Hyatt (3), enables a better visualisation of the relationship between flow and volume. The MEFV Curve is also considered to be a more sensitive index of early obstructive lung disease (4). The curve is plotted with lung volume on the abscissa and the instantaneous maximal flow rate ($\dot{V}_{max}$) on the ordinate. Since sophisticated equipment required for determining $\dot{V}_{max}$ are not available in most institutions in India, it was felt that as an alternative, an expiratory flow volume curve may be plotted by using mean flow rates ($\dot{V}_{mean}$) obtained from a spirogram.

The mean flow rate at different lung volumes can be calculated by measuring the average flow over various ten percent volumes of FVC, but this involves measuring time in fractions of seconds over specific volumes in fractions of liters; flow rate can also be determined from the slope of the line connecting the two volume points. These methods are rather tedious for clinical purposes and are also liable to errors. The method presented here is simpler and more accurate, and comprises of computing flow rates by just measuring the volume between two 0.1 second time lines. Hyatt (personal communication) suggested that the data obtained by this method could be utilised to plot a mean flow volume curve of forced expiration. This paper presents tne results of a preliminary study using $\dot{V}_{mean}$ instead of $\dot{V}_{max}$.

Data were obtained in 50 healthy young non-smoking medical students between 20 and 29 years of age, using a McKesson Vitalor (The Vitalor has a speed of 20 mm/second. The recording chart has clear rulings, the intervals between the vertical lines representing 0.1 second, and horizontal lines 0.1 litre). The highest FVC tracing with the highest one second Forced Expiratory Volume ($FEV_{1.0}$) out of three trials was analysed. The volumes at

25, 50, 62.5, 75 and 87.5 per cents of the FVC were marked on the tracing. The volumes between the 0.1 second vertical lines on either side of the point were read, and the flow rate expressed as litres per second (LPS). An illuminated magnifier was used to take the readings with greater accuracy. If the volume point was on, or close to a vertical time line, the flow rate was calculated from the volume over 0.2 second. This method eliminates any impreciseness in reading on the time scale, and reduces errors in reading of the volumes in litres to the second decimal point, and is sufficiently accurate for clinical purposes. The volumes were corrected to Body Temperature, Pressure saturated with water vapour (BTPS). The Mean Expiratory Flow Volume Curve was constructed by plotting the mean flows on the ordinate, against the five lung volume points on the abscissa. The five points were chosen as they were convenient points covering a wide range of FVC tracing at suitable intervals. (including most of the effort independent later portion of FVC). This also enabled a comparison of our data with that of Black *et al.* (2) who have plotted $\dot{V}_{max}$ at these points.

The mean standard deviation and median values are shown in Table I. The mean and median values are about identical as found by Knudson *et al.* (5). Fig. 1 shows the Mean Expiratory Flow Volume Curve with the 90th and 10th percentile values of flow at each lung volume.

TABLE I : Showing Mean Expiratory Flow at varoius percentages of FVC in 50 male subjects (20-29 years).

	Mean expiratory flow in litres per second at per cent of FVC				
	25%	50%	62.5%	75%	87.5%
Mean	5.65	4.39	3.24	1.93	0.81
S.D.	0.78	1.14	0.81	0.70	0.37
Median	5.58	4.35	3.28	1.96	0.79

The shape of the Mean Expiratory Flow Volume Curve is very similar to the MEFV curve of Black *et al.* (2) though the flow rates are lower. For studying the reproducibility of forced expiratory spirogram, Walter and Nancy (7) measured in 17 South Indian subjects from Vellore between 17-24 years, the Forced Expiratory Flow (FEF) between 20 and 30%, 45 and 55%, 70 and 80% and 85 and 95% FVC; these would reflect the mean flows at 25, 50, 75 and 90% of FVC. Except for the flow at 25% which is much higher, the other flow rates are quite close to our values.

It is also found that the coefficients of variation of the mean flow at various lung volumes are rather large. Hyatt and Black (4), discussing the current perspective of the

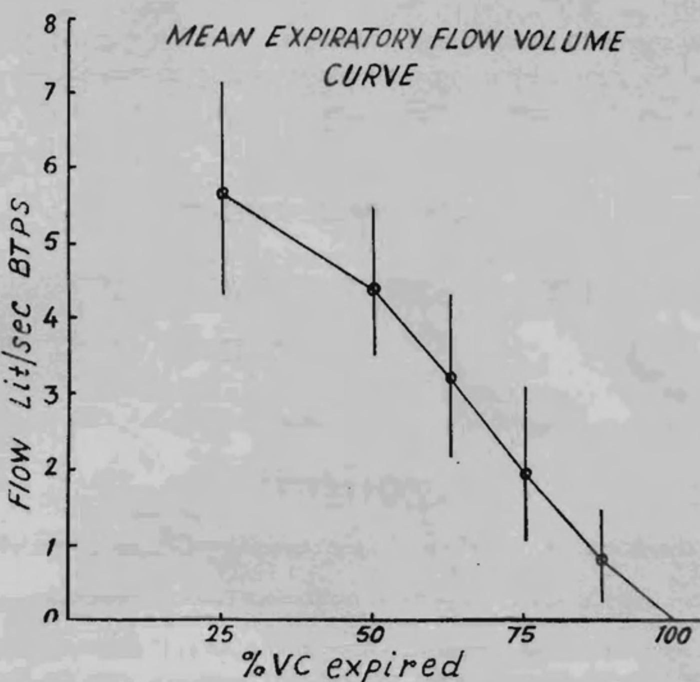

Fig. 1 : Mean Expiratory Flow Volume Curve.
Vertical lines connect 90th and 10th percentile values.

Flow Volume Curve have commented upon the wide variability of the curves in normal subjects and recommended the need for obtaining data in large number of normal subjects. Knudson *et al.* (5) who studied MEFV Curves in 746 non-symptomatic non-smokers found a large variability. However, this is the feature present in many of the spirometric parameters like $FEF_{200\text{-}1200}$, $FEF_{25\text{-}75\%}$ and $FEF_{50\text{-}75\%}$

The method described in this paper is a simple procedure to plot Mean Expiratory Flow Volume curves. From the shape of the curve it appears that for clinical purposes, it may be enough if three points are chosen to plot the curve, viz. mean flow at 25, 50 and 75 per cents as done by Peslin *et al.* (6) in a comparative study of various methods of reading MEFV curves.

It has recently been shown by Bhalla *et al.* (1) that substituting mid-expiratory flow rate ($FEF_{25\text{-}75\%}$) derived from a spirogram was as satisfactory as using $\dot{V}max_{50}$ in their index for detecting upper airway obstruction. Since the mean flow rates between 25 and 75%, and 50 and 75% of FVC, are slightly less, but appear to be fairly close to and correlate well with $\dot{V}_{max}$ at 50% and 62.5% respectively, the use of mean flow as an alternative to maximum flow seems to be valid and justifiable. It is felt that the information obtained by plotting mean FV curves by using a simple recording spirometer would yield about as much information as the classical MEFV curve obtained with the aid of expensive and sophisticated equipment.

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