Section of Measurement in Medicine

President Percy Cliffe MB

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with the Breathing Club

Reporting Lung Function Tests: Criteria and Methods, including the use of Computers [*Abridged*]

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Current Practice in Six London Lung Function Laboratories

Two patients attended six lung function laboratories in London taking with them chest X-ray films and clinical summaries. One was a man aged 62 (Case 1) with a clinical diagnosis of asthma, chronic productive cough and hypertension, and a history of two myocardial infarcations and an episode of overt heart failure. The second, a woman aged 28, had long-standing pulmonary sarcoidosis (Case 2). Each laboratory was requested to investigate the patient according to its normal procedure. Arterial puncture was forbidden, although representative figures for blood gases could be obtained from the organizer if they would normally have been required. Exercise testing and the administration of isoprenaline were forbidden for Case 1. Both patients completed this rigorous obstacle course and subsequently expressed considerable interest in and some amusement at their experience. The laboratories concerned were at the Institute of Diseases of the Chest (Dr F J Prime), the Brompton Hospital (Dr T J H Clark), St Bartholomew's Hospital (Dr J Collins), the MRC Air Pollution Unit, St Bartholomew's Hospital Medical College (Professor P J Lawther), The London Hospital (Dr D T D Hughes), and the Hammersmith Hospital (Dr J M B Hughes). Only one of these centres gave values in SI units.

It was clear that a common batch of tests exists which was applied to both cases (Table 1). Various other measurements were quoted by one or more of the six laboratories. One laboratory proposed an exercise test for Case 2, but the subject was unable to attend a second time. Laboratories applying the tests shown did so in both cases, except where stated, suggesting that whereas each laboratory used a slightly different batch of tests, each tended to apply them without particular discrimination in two widely differing cases.

Table 1

Tests used in Cases 1 and 2

By all laboratories
FEV_1
FVC and/or VC
FEV_1/VC or FEV_1/FVC
RV
TLC
RV/TLC
TL_{CO} (single-breath 5, steady-state 1)
By some laboratories
FRC (5)
IC (5)
ERV (3)
R_{AW} and SG_{AW} (3)
K_{CO} (3)
Rebreathing P_{CO_2} (3 for Case 1, 1 for Case 2)
PEFR (3)
MMEF (2)
TV, rate and V at rest (2)
Mixing efficiency (1)
MEFV loop + helium response (1 for Case 2)

Figures in parentheses indicate the number of laboratories using the test

There was some variation in practice concerning the use of unforced VC as opposed to FVC, and the calculation of forced expiratory ratio. Four laboratories clearly measured both VC and FVC in separate manoeuvres, and two found large differences in Case 1. Four calculated FEV_1/FVC and one FEV_1/VC. In the sixth laboratory, VC and FEV_1/VC were quoted, but it seems likely that VC was in fact obtained by a forced manoeuvre.

A larger series of repeated measurements on these patients from the Middlesex Hospital gave

some idea of the spontaneous variation to be expected. When this was allowed for, the measurements made in the six laboratories were reasonably comparable, with the exception of TL_{CO} and R_{AW} in Case 1. In the five laboratories where TL_{CO} was measured by the single-breath method it varied from 10.5 to 20.4 ml CO/min/mmHg against a predicted normal of 26. K_{CO} was calculated in three laboratories, and was normal for the two highest readings of TL_{CO} and low on the third occasion. The presence of the word emphysema in the report was markedly dependent on the value of TL_{CO} obtained. If it is accepted that a low transfer factor (perhaps corrected for alveolar volume) tends to indicate the presence of emphysema in a patient with chronic airways obstruction, then some of these results were wrong. If on the other hand they represent true spontaneous variation then it is unlikely that the measurement can be used to detect a non-labile pathological condition. A study of repeatability of TL_{CO} in patients with chronic airways obstruction is clearly required.

R_{AW} in Case 1 was found to be 5.6, 3.7, and 7.3 $cmH_2O/(l/s)$. While this variation may have been real, experience of this man's flow-pressure loops leads me to suspect that there was much scope for observer variation. In two laboratories the measurement was quoted to three decimal places, eg. 3.745 $cmH_2O/(l/s)$. Two laboratories quoted the wrong units and the third did not quote the units at all. In Case 2, R_{AW} was quoted as 1.569, 1.618, and 0 (*sic*) respectively.

Five laboratories quoted predicted normal values and three gave their results as such and also as a percentage of the predicted normal. One laboratory quoted a normal range. The normal values quoted showed an unacceptably wide variation between laboratories for several variables in Case 1, and for FEV_1 in Case 2 (Table 2). In Case 1 this is partly due to error in one laboratory leading to the patient apparently having an acute attack of shortness of stature. In Case 2 the lowest value for predicted Fev_1 is almost certainly a misprint.

Table 2

Normal values: variation between the six laboratories

Test	*Range of normal values predicted*	
	Case 1	*Case 2*
FEV_1 (litres)	2.6–3.1	2.3–2.95
VC (litres)	3.7–4.2	3.1–3.3
FRC (litres)	3.5–3.9	2.4–2.55
TLC (litres)	5.9–6.7	4.55–4.8
RV (litres)	2.2–2.3	1.35–1.4
RV/TLC (%)	35–38	29

In Case 1 bronchodilator response was tested in five laboratories by repeating the forced expiratory measurements. In one laboratory absolute lung volumes and R_{AW} were also repeated and obvious decreases in hyperinflation and R_{AW} were noted in the absence of a change in FEV_1. FEV_1 increased by more than 0.1 litre on two occasions out of six.

Interpretation in Case 2 was relatively consistent, since a restrictive mechanical defect and a defect in gas transfer were uniformly detected. Two reports summarized the most striking numerical findings. All gave some functional interpretation, e.g. 'restrictive pattern'. Three stated that the findings were compatible with a diagnosis of sarcoidosis.

Case 1 was purposely selected as a good example of the applied respiratory physiologist's semantic nightmare. All reports gave some functional interpretation of results, and the interpretations were broadly similar, though varying in detail. The clinical diagnosis mentioned in the reports were as follows: intrinsic airways disease; chronic bronchitis, heart failure; asthma, heart failure; asthma, emphysema; asthma, emphysema (?? fibrosing alveolitis); no clinical diagnosis mentioned.

Dr Saunders in answer to Professor C M Fletcher said that only one laboratory out of six gave a range for the reference values.

Dr J E Cotes thought it unsatisfactory that in relation to the diagnosis of emphysema no laboratory had measured the compliance of the lung or the recoil pressure.

Dr Saunders said that not only was it not measured, but there was no written space for it on any of the report sheets. In answer to Dr M Green, Dr Saunders said that in patients with airways obstruction, no single number could be obtained for the airways resistance measured by the plethysmograph method. This was due to difficulties in interpreting the pressure-flow loop.

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Investigation of Pulmonary Function: Current Practice in Ten Provincial British Laboratories

Ten physicians responsible for respiratory investigation services answered a questionary about their practice in 1974–5 in the clinical investigation of individual patients. Three were from academic units, seven from routine hospital respiratory laboratories. Nearly all laboratories investigated each month about 25 patients who needed a clinical assessment as well as a numerical report. The numbers of patients referred for routine tests varied considerably; most of the reports were based on the numerical results. Tables 1 and 2 show the use made of certain tests.

Nine respondents agreed to comment on the results obtained from an actual patient, who had