ASSOCIATION OF RESPIRATORY TECHNICIANS AND PHYSIOLOGISTS

ISSUE NO. 23 OCTOBER 1984

BREATH

CONTENTS

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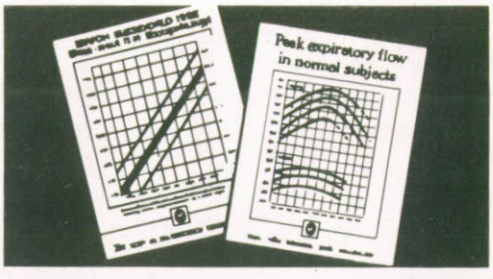

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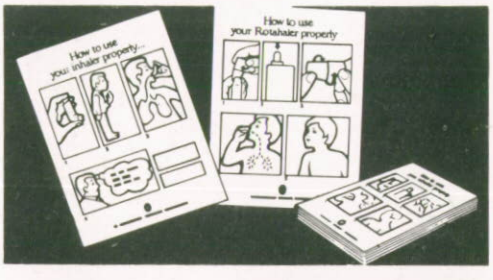

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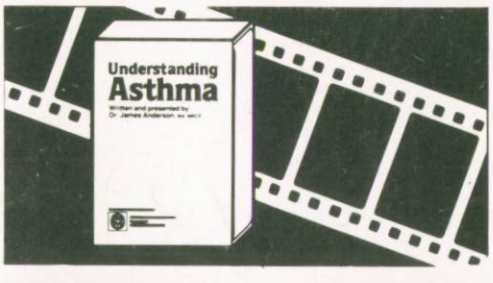

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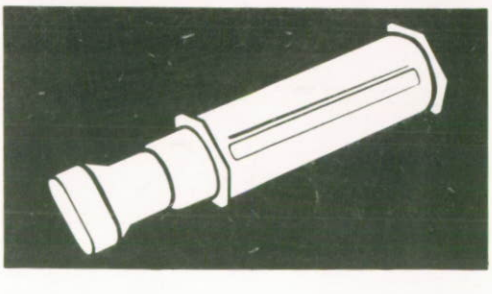

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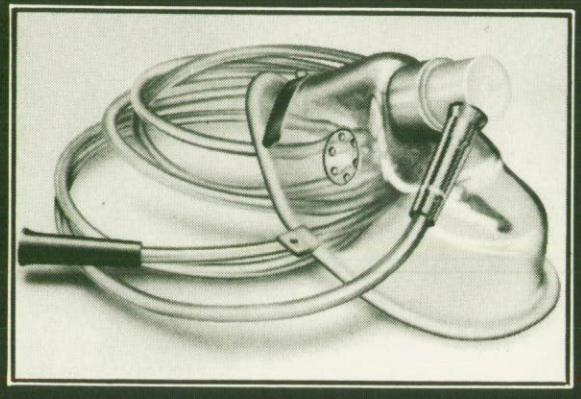

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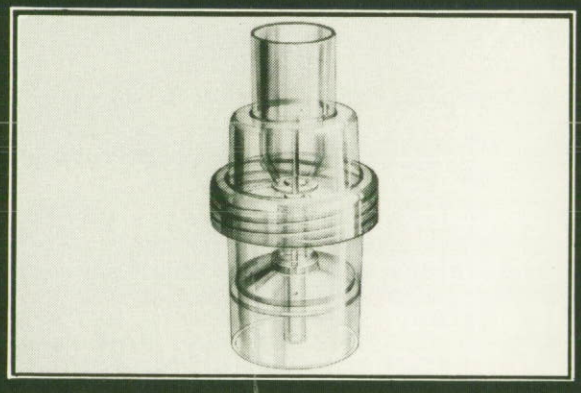

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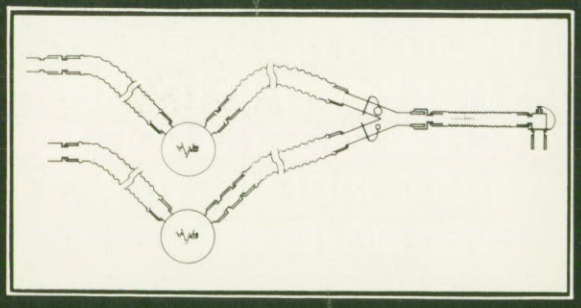

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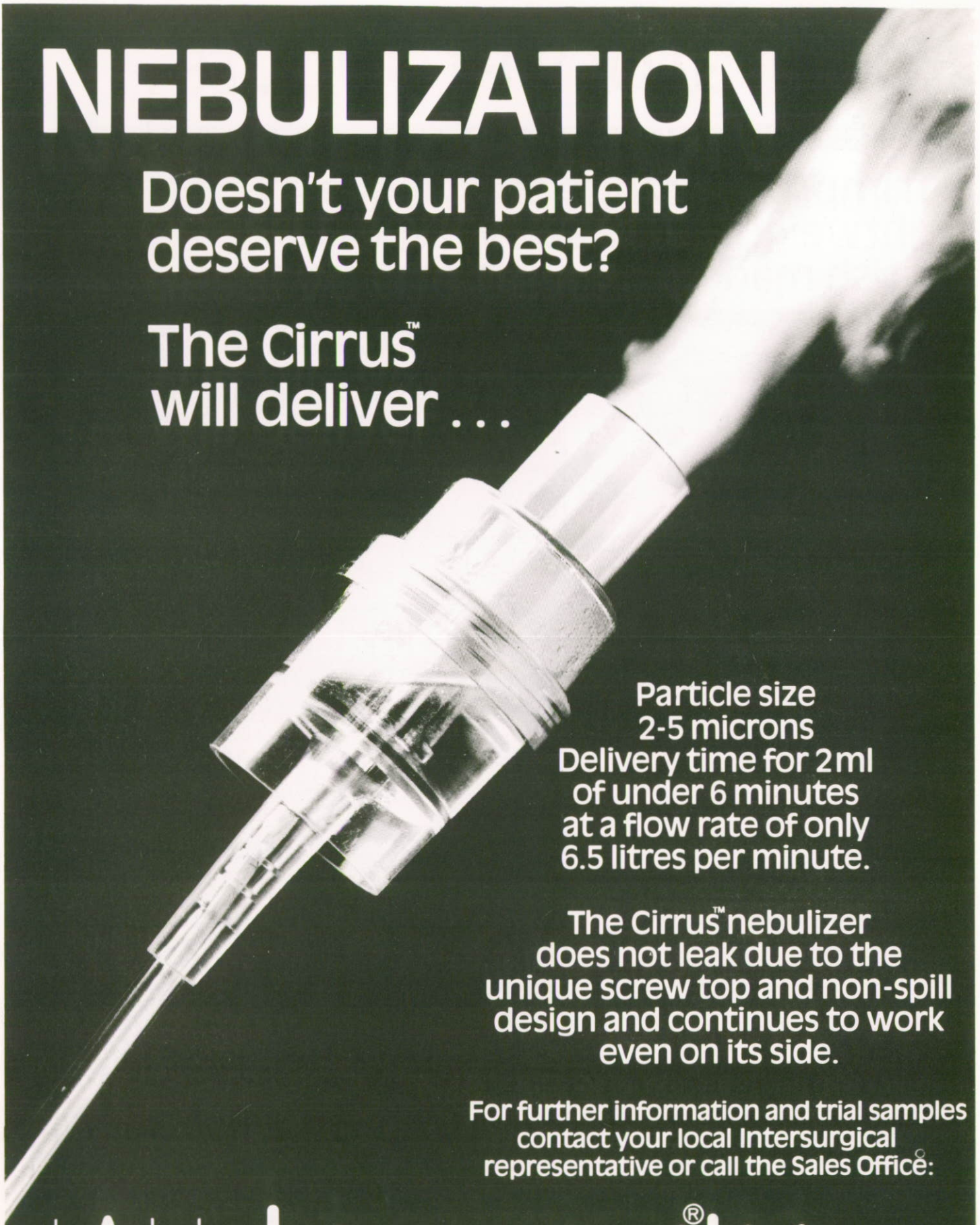

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EDITORIAL

Smoke Rings

The Book of the Year for anyone working in the health industry must surely be Peter Taylor's "Smoke Ring" released a few months ago. Smoke Ring is an account, researched with care and with detailed references, of the tobacco industry's world-wide strategy for promoting its sales and for defeating any counter-efforts by health-conscious individuals or organisations. No shock-horror effects are required; the subject matter is quite sufficient.

The "Smoke Ring" protects six vast multi-national companies; British American Tobacco is the largest with a quarter of a million employees, and between them they produce about 40% of the world's cigarettes (the remainder coming from stae monopolies in countries such as France, Italy, Japan, the Soviet Union and China). Their weapons are the strong addiction to nicotine without which few would bother to smoke, and their advertising which promotes the habit and attempts to persuade the addicts that the industry is doing them a great favour.

The facts about cigarette smoking have been known since the 1950's and were published in successive reports from the Royal College of Physicians (1962 to 1983) and the American Surgeon-General. The stark conclusion, based on a very large number of subjects, is that the risk of lung cancer increases with the number of cigarettes smoked; this disease now constitutes a major epidemic with deaths running at about 30,000 per year in this country. The scientific evidence seems incontrovertible though the cry inevitably goes up that "it's just statistical" and by inference that there is no real proof that cigarette smoke can cause cancer. Indeed, not every link in the chain of evidence has been discovered, but it is mere pedantry to suggest on this account that smoking is completely harmless. To look at a parallel situation, the manufacturers of domestic electrical equipment are legally obliged to observe stringent safety standards. Why shouldn't the same constraint be placed on the tobacco industry? The onus should be on the producer to show that the products are safe, and not on the consumer to prove that they are unsafe.

The tobacco industry itself, some years ago, did take steps to investigate this matter and a large research laboratory was established in Harrogate. Many thousands of mice had their skins painted with cigarette tar to see how many of them developed skin cancer. It was clear by the end of the study that the tar was highly carcinogenic but in spite of this, the industry has continued to put forward the view that the case against cigarette smoking has not been proven.

The analogy with the London cholera epidemics of the 19th century has been pointed out many times. In one outbreak 500 people died in ten days in the London district of Soho, but after closure of the Broad Street pump the epidemic virtually ceased; this was long befor the discovery of the responsible micro-organism.

Advertising is the industry's big gun. Around the world, the tobacco industry spends over one thousand million pounds every year to ensure, as Peter Taylor puts it, that "cigarettes are associated with glamour, success and sophistication, instead of lung cancer, bronchitis and heart

disease''. A great many magazines and newspapers are dependent upon this source of revenue; the tale goes of one of the up-market Sunday newspapers which was in the habit of taking about three quarters of a million pounds each year in cigarette advertising. One edition of the colour supplement contained an article which not only knocked tobacco heavily, but actually named a number of the brands; shortly after, a large amount of their advertising moved elsewhere.

One of the most famous advertisements is that of the Marlboro cowboy with his image of health, the open air life and so on. Taylor went to the States and interviewed six genuine American cowboys, all at one time heavy smokers but by then in an advanced state of lung cancer or emphysema; in 1976 he made a film about it for Thames Television. One of the American TV companies expressed interest in it, whereupon the tobacco company took out a High Court injunction to prevent it being shown. This was successful for a time but eventually a copy fell into the hands of a Californian anti-smoking group and the film was widely shown on American TV; it even appeared as a major item in a schools health project which was one of the main wishes of the original participants in the film. By then of course none of them were around to see it.

After the ban on TV advertising, the tobacco industry moved heavily into the field of sports sponsorship. They have supported cricket,tennis, golf, snooker, darts, motor racing and show jumping and this allows the companies to associate their products with health and vigour, to get round the TV advertising ban and to gain hours of television exposure for which they pay no advertising fees. What is more, the tobacco companies have diversified their interests into a multitude of other spheres so that they can get their brand names attached to non-tobacco products. One company, for instance, was able to get its logo onto the chest of a lady Wimbledon champion, ostensibly as an advertisement for sportswear.

The tobacco industry has also started to sponsor the arts and has become the patron of orchestras, theatres and opera companies. The Glyndebourne Festival Opera, for instance, is heavily supported by Imperial. All these activities are very much minority interests compared with sport so one might wonder what the sponsors are getting out of it. What they get, of course, is respectability and a clean image that is far removed from death and disease. This is where they entertain and influence important figures from civil service, banking, broadcasting and Parliament. Many of those being sponsored may have qualms about accepting money from such a source, but can fall back on the argument that they badly need this support and that there's no harm in ill-gotten gains being used in a good cause.

The Treasury receives annually some three thousand million pounds in revenue from the sale of tobacco. About 75% of the cost of a packet goes back to the Chancellor of the Exchequer and on top of this, the industry provides the nation with thousands of jobs. Small wonder that no Government has been keen to see any major cuts in tobacco sales. The industry can call on about 100 MPs to support their cause, including their paid parliamentary consultants and those with constituency or trade union connections. In some places tobacco is still a major employer where other industries are in decline. The Tobacco Workers Union is naturally rather sensitive about the matter, although the TUC itself has recently taken an anti-smoking line.

A number of health ministers have attempted to bring in more stringent legislation. Sir George Young who was Junior Health Minister in the Conservative Government of 1979 took a harder line than any of his predecessors and tried to introduce a total ban on all cigarette advertising and sponsorship. This immediately brought the Health Department into conflict with the Minister for Sport whose brief was to obtain as much money as possible for *his* patch. However, the Government simply was not willing to face a major battle with the industry and Sir George was moved to the Department of the Environment where he would presumably be less of a nuisance.

The power exerted by the tobacco lobby in the United States is even greater. Every year the industry's contribution to the revenue in federal and state taxes is some twenty thousand million dollars and the raw material is produced by over half a million farmers in the Southern states. By a federal ''price support'' scheme, the farmers are guaranteed a clear profit, though critics from time to time point out the anomaly of supporting the industry and then spending large sums to discourage smoking and in counteracting its effects. The industry's point of view is represented in Washington by the politicians from the tobacco-growing states whose power and drive stem from the fact that they are politically doomed if they fail to be seen fighting tooth and nail for the farmers' interests. Favours are given and received and the subsidy continues. In 1980, Jimmy Carter who was soft on health, lost the tobacco states and the election. Ronald Reagan, who promised to support the tobacco subsidy, went to the White House.

The opponents of the tobacco lobby are the Government's health departments (albeit with a somewhat wavering commitment due to the revenue factor), organisations such as the Royal College of Physicians and the American Lung Association, and the Health Education Council. Then there are voluntary organisations such as Action on Smoking and Health (ASH) and its American counterpart of the same name, the American GASP (Group Against Smokers' Pollution), and the engagingly named BUGA UP (Billboard Utilising Graffitists Against Unhealthy Promotions), an Australian group who have taken more radical action by ''modifying'' cigarette advertisements with aerosol paint spray. The total budget of all these organisations put together is miniscule compared with the amount put into advertising by the tobacco industry.

What is the tobacco industry's response to the accusations that cigarette smoking is one of the main causes of death and disability in our community? Their strategy is not to talk about the health issue if it can be possibly be avoided; if they are forced onto this ground they respond with the hollow argument that ''there's no real proof''. (Why then have they put so much money into manufacturing and promoting the low tar cigarette if they don't believe that the tar is dangerous?) Instead, they concentrate on the costs of implementing government anti-smoking legislation and on the interference with individuals' freedom to participate in a harmless and pleasurable activity.They stigmatise anyone concerned with the health hazards as an irrational zealot. They argue that they provide jobs in a hard economic climate, are an essential source of government revenue and act as patrons of sport and of the arts. No doubt, but the result for the smoker is disability and death; the bottom line is about patients dying of lung cancer and chronic disease because they got hooked as children and teenagers. Some freedom, some choice!

Reference

Peter Taylor. Smoke Ring: the Politics of Tobacco. Published by The Bodley Head Ltd., London (1984).

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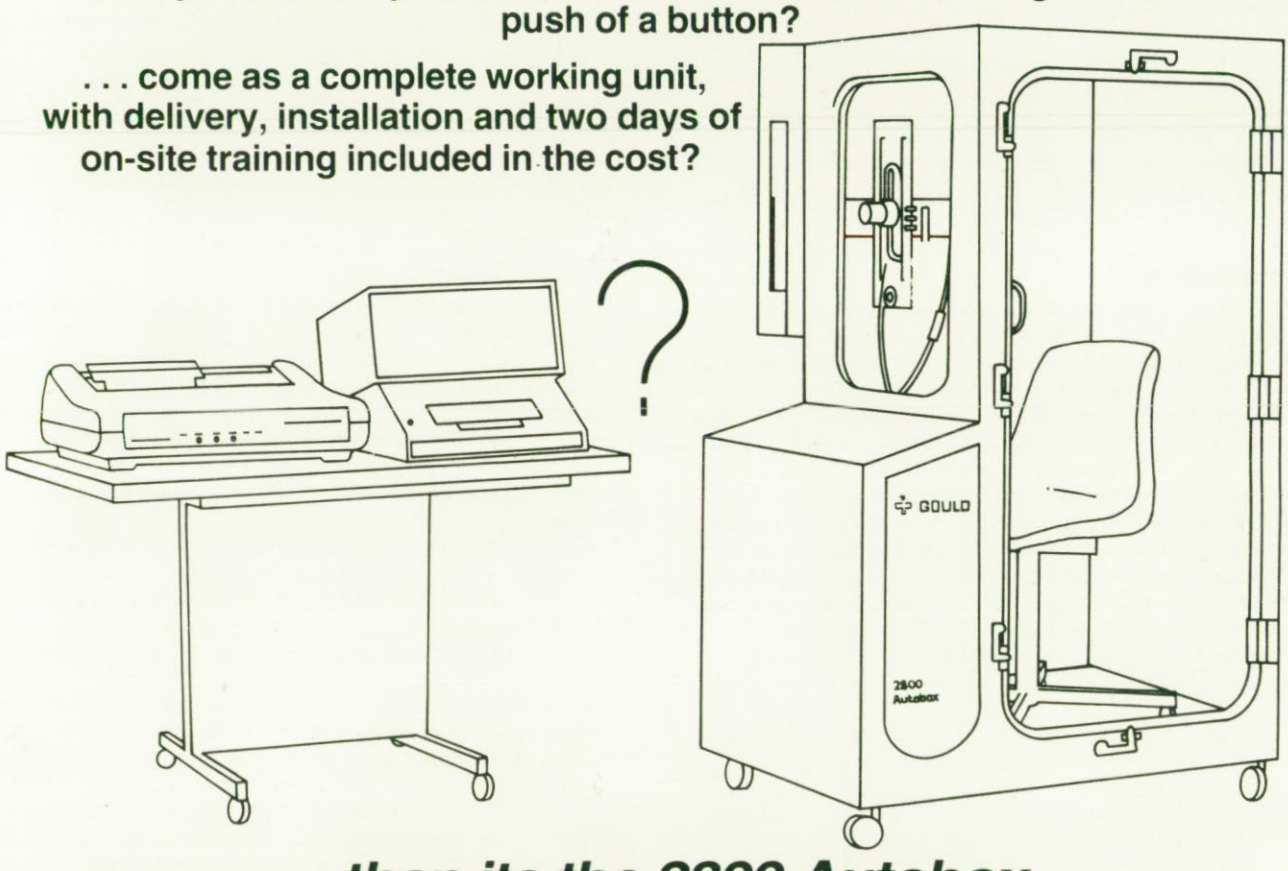

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PROBLEMS WITH THE BODY BOX
A review of potential errors in lung volume measurement

H R Gribbin
The London Chest Hospital

Summary
The whole body plethysmograph method of measuring thoracic gas volume (Vtg) developed by Dubois et al[1] depends on the assumption that the change in alveolar pressure during the panting manoeuvre is the same as the change in pressure measured at the mouth. Recent studies have shown that in the presence of increased airways resistance, alveolar pressure changes may be underestimated at the mouth with consequent overestimation of Vtg and derived lung volumes such as total lung capacity. In addition, the presence of abdominal gas, long considered unimportant, may influence the value of Vtg depending on which respiratory muscles are used in panting. These recent findings require some reassessment of the place of the body plethysmograph in the routine measurement of lung volumes in clinical practice.

Introduction
In 1956 Dubois and co-workers[1] introduced a method of measuring thoracic gas volume (Vtg) by means of the whole body plethysmograph or 'body box'. It was quicker and more convenient than other methods available at that time and soon became widely used. In clinical practice it was found to give a better estimate of total lung capacity (TLC) than the helium dilution method in patients with airflow obstruction and to be much less time consuming. Many of the original technical problems of the body box have been overcome and more recent modifications make the present day commercial models relatively easy to operate. Microcomputers with on-line facilities are now commonly used to speed up the lengthy calculations.

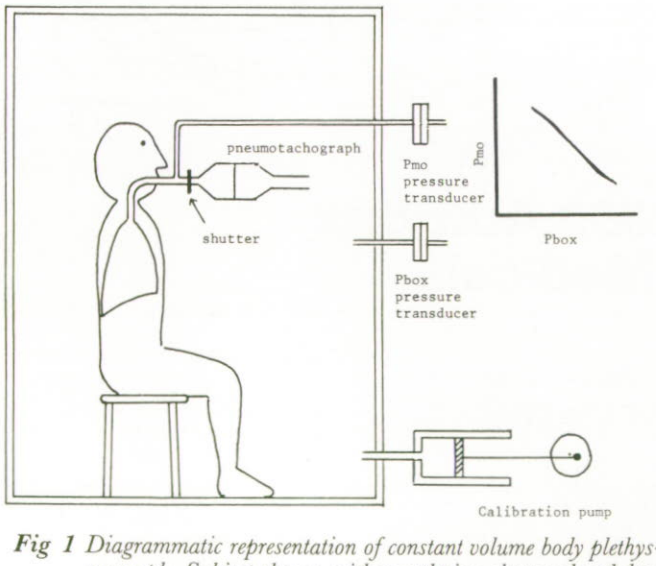

Fig 1 Diagrammatic representation of constant volume body plethysmograph. Subject shown with mouthpiece shutter closed during panting manoeuvre. Pneumotachograph is used for parallel measurement of airways resistance but is not required for Vtg. The value of Pbox/Pmo can be obtained directly by measuring the slope of the line on the X-Y display but some models now have microprocessors which derive this independently.

The physiological basis of the measurement, based on Boyle's law, was not challenged for over 20 years because body box results were generally consistent with expectations. One situation, however, raised some suspicions. In acute experimental asthma, (exercise-induced for example) large and rapidly developing increases in TLC seemed to occur[2]. Although few respiratory physiologists doubted that hyperinflation often accompanied acute asthma, the magnitude of the increase in TLC was difficult to understand in mechanical terms and raised questions as to whether some of the increases could be due to artefacts. Research into this problem has produced a detailed re-examination of the assumptions underlying Dubois' technique and the results are important for all involved in day to day use of the body box for measuring lung volumes.

Methodology
Dubois' method for estimating Vtg is based on Boyle's law, ($V_1P_1 = V_2P_2$).

Applied to a subject making an inspiratory effort against the shutter.

$$Vtg.\ Patm = (Vtg + \Delta V)\ (Patm - \Delta Palv)$$

Solving for Vtg and assuming the product $\Delta V.\ \Delta Palv$ to be negligible

$$Vtg = Patm.\ \Delta V/\Delta Palv \qquad \text{Equation 1}$$

or with particular reference to the constant volume plethysmograph

$$Vtg = Patm.\ \Delta Pbox/\Delta Pmo \qquad \text{Equation 2}$$

where Vtg = thoracic gas volume, Patm = atmospheric pressure and ΔV, $\Delta Pbox$, $\Delta Palv$ and ΔPmo are the *changes* in Vtg, plethysmograph, alveolar and mouth pressures respectively during the panting manoeuvre.

The subject, wearing a nose-clip, sits in an airtight box (constant volume, variable pressure plethysmograph) and breathes through a mouthpiece and pneumotachograph equipped with a remotely controlled shutter (Fig 1). At the end of a quiet expiration the shutter is activated, completely closing the mouthpiece chamber and the subject is asked to pant gently in and out against the obstruction. The cheeks and floor of the mouth should be supported with both hands while this is done. In this situation, with the glottis open, Dubois argued that pressure changes within the lung and conducting airways including the mouth would be equal so that the change in alveolar pressure (Palv), should be the same as the change in mouth pressure (Pmo). During panting against the shutter, the respiratory muscular efforts during attempted inspiration result in thoracic gas decompression with a fall in Palv and Pmo and a rise in the pressure inside the plethysmograph, Pbox. The opposite occurs on attempted expiration. The pressure changes on the mouth side of the shutter and in box pressure are measured with sensitive differential pressure transducers.

Equation 1 shows that to calculate Vtg we need to know the two variables ΔV and ΔPalv. During the panting manoeuvre ΔPalv = ΔPmo, and ΔPmo can be measured. Although ΔV can be assessed directly in some body plethysmographs (variable volume, constant pressure or pressure compensated), by Dubois' technique ΔV is measured indirectly from the change in box pressure, ΔPbox. The calibration of ΔPbox for change in thoracic gas volume is carried out separately from the panting manoeuvre and to do this most boxes are equipped with a small sinusoidally driven piston pump. Usually the subject is asked to hold the breath for a short time while the pump is activated. The observed change in Pbox is then equivalent to the known volume of the piston. In practice the required ratio of ΔV/ΔPalv (Equation 1) is replaced by the ratio ΔPbox/ΔPmo (Equation 2). This is usually found by displaying Pbox against Pmo on an X-Y recorder or oscilloscope unless the calculations are carried out by a microprocessor. After the appropriate scaling and calibration, the tangent of the slope ΔPbox/ΔPmo is substituted in Equation 2 to find Vtg. To measure TLC the subject is asked to inspire maximally after the shutter is opened and the volume inspired (inspiratory capacity) is added to Vtg, all volumes being calculated at BTPS.

Although the volume of gas measured by Dubois' technique is known as the thoracic gas volume or Vtg, the actual volume measured is all the compressible gas inside the subject which includes air in the abdomen. Dubois was aware of this problem and concluded that the abdominal gas volume (Vab) was small in normal subjects (of the order of 100 to 150ml) and unlikely to cause spurious elevation of Vtg to an important extent. The contribution of abdominal gas to the volume measured by Dubois' technique was therefore largely forgotten.

The critical assumption in the method however, is that change in alveolar pressure can be assessed by measuring the change in mouth pressure. Again Dubois was aware of the potential problems with this assumption and pointed out that major artefacts such as panting with a closed glottis could be spotted if the Pmo was greatly reduced. There were, however, more subtle influences at work which were not initially apparent.

Abdominal Gas Volume

Two separate observations led to the same conclusion about abdominal gas and its influence on Vtg. Brown and colleagues [3,4] demonstrated that in both normal and asthmatic subjects TLC measured by Dubois' technique was greater if the subject panted near to residual volume (RV) than if panting was at functional residual capacity (FRC) or near to TLC (Fig 2). The discrepancy in the group of normal subjects was as much as 500 ml. Measuring intra-abdominal pressure by means of a gastric balloon, they observed that the pressure variations were greater when the panting manoeuvre was performed near to RV than during panting near to TLC. Thus near to RV there are larger changes in abdominal gas volume (Vab) which are recorded as ΔV and ΔPbox in the plethysmograph without the appropriate additional pressure swings in Pmo, since the abdominal gas is not in continuity with gas in the lungs or airways. It follows that at RV the value of ΔPbox/ΔPmo will increase and Vtg will be over-estimated.

In a separate study, Habib and Engel[5] asked their subjects to pant near FRC using either intercostal and accessory muscles or diaphragm. This was achieved by emphasising rib cage or abdominal movement respectively during inspiratory efforts against the shutter. For the group, TLC obtained during intercostal and accessory muscle panting exceeded that obtained during diaphragmatic panting by up to 900 ml. The explanation again rested on abdominal gas changes. Inspiratory panting with intercostal and accessory muscles produced greater abdominal gas decompression than inspiratory panting with the diaphragm. Using the diaphragm to make inspiratory efforts allowed less of the negative intra-thoracic pressure to be transmitted to the abdominal gas, with smaller abdominal pressure swings and hence less decompression of abdominal gas. Using intercostals and accessories, the larger changes in Vab are picked up as ΔPbox thus raising the value of ΔPbox/ΔPmo and causing the value of the derived Vtg to be overestimated.

It seemed possible that patients with asthma might use different ways of panting depending on their clinical state. For example, with worsening airflow obstruction RV would be increased, FRC might be closer to RV and panting might then produce larger abdominal pressure swings with consequent overestimation of Vtg. Neither group of researchers however, could find evidence for this in stable or induced asthma. Habib and Engel[5] examined a number of patients with a variety of lung diseases and found a tendency to pant using the intercostals, but the changes produced in Vtg were relatively small with a maximum error of 340 ml due to Vab. It seems likely that abdominal gas is not an important source of error in estimating Vtg but the possibility should be considered especially if discrepant values are found or where subjects are noted to be panting near to RV.

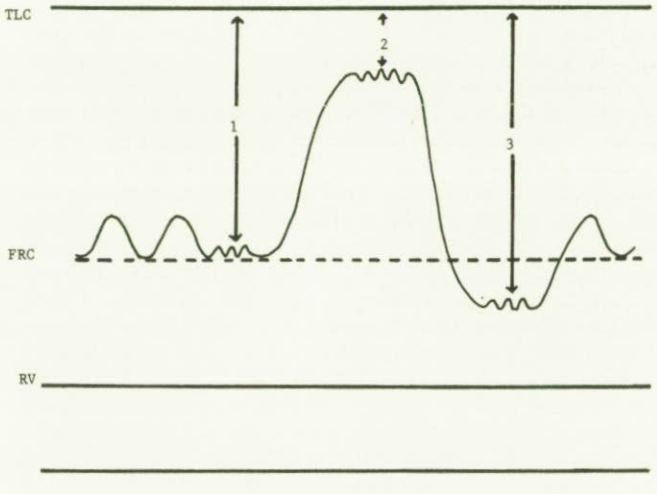

Fig 2. Spirogram showing panting manoeuvres at lung volumes near FRC(1), TLC(2) and RV(3). Values for TLC derived from Vtg plus inspiratory capacity. TLC values are greater for panting near RV(3) than at FRC(1) or near to TLC(2).

Incomplete transmission of alveolar pressure swings to the mouth

Since the calculation of Vtg depends on the assumption that alveolar pressure is transmitted directly to the mouth, any factor which attenuates ΔPalv can lead to an overestimation of Vtg. Conceptually the alveolar space, airways and mouth are viewed as one unit and the wall of the airways and mouth are considered to be rigid with negligible compliance. In a series of elegant but invasive physiological studies Rodenstein, Stanescu and colleagues have shown conclusively that upper airways compliance – the potential collapsibility of the cheeks and buccal cavity – can in circumstances of increased airways resistance attenuate the transmission of alveolar pressure swings to the mouth during the panting manoeuvre[6]. Their experimental procedure is shown in Fig 3.

At a given lung volume the change in alveolar pressure (ΔPalv) is the same as the change in pleural pressure (ΔPpl). In all the studies to be described below the true alveolar pressure change is therefore assessed by the change in pleural pressure measured with a balloon positioned in the lower third of the oesophagus. If ΔPalv and ΔPmo are equal during the panting manoeuvre then displaying ΔPpl and ΔPmo against ΔPbox (ΔV) should give two lines of equal slope and this held good for a group of normal volunteer subjects. (Fig 3a). Airways resistance was then increased by partially inflating a small balloon in the lower trachea. This resulted in a fall in ΔPmo compared with ΔPpl (Fig 3b). Next an endotracheal tube was inserted under local anaesthesia of the vocal cords. With the endotracheal tube in place, and the small balloon still partially inflated in the lower trachea panting produced the same change in ΔPpl and ΔPmo as in Fig 3a. (Mouth pressure in this part of the study was the pressure recorded at the mouth end of the endotracheal tube which was occluded during the panting manoeuvre).

The three experiments suggested strongly that some factor in the upper airways influenced the transmission of alveolar pressure swings to the mouth in the presence of increased airways resistance. Bypassing the upper airway by means of the endotracheal tube effectively removed the attenuation of alveolar pressure. The current explanation is that during the panting manoeuvre there are small airflows between the mouth and the lungs which are generated by the slight inward collapse of the cheeks and buccal floor on inspiration and slight outward movement on expiration as airway and mouth pressure become alternately negative and positive. Pressure is dissipated in moving the air from mouth to lungs on inspiration and vice versa on expiration. If airway resistance is low then negligible pressure is needed to produce the small airflows but in the presence of high airway resistance more pressure is required and a gradient is formed along the length of the airway from alveolus to mouth. The experimental procedure used to demonstrate this is of course highly artificial but with more direct relevance to clinical practice, the same group of investigators went on to show that similar discrepancies occurred in experimentally induced asthma. Using methacholine-induced bronchoconstriction they demonstrated that Vtg estimated from Pmo was considerably higher than Vtg estimated from Ppl measured with an oesophageal balloon[7] and TLC was thus over-estimated by mouth pressure measurements. ΔPmo systematically underestimated ΔPpl (and hence ΔPalv) and the suggested mechanism by analogy with the earlier studies described above, was the ability of compliant upper airways to attenuate alveolar pressure swings during the panting manoeuvre in the presence of methacholine-induced increases in airways resistance.

Similar conclusions in asthma[8] were reached independently by other researchers and later extended to include patients with chronic airflow obstruction where large overestimates of TLC can occur. In the study of Rodenstein and Stanescu[9], TLC using ΔPmo averaged approximately 400 ml greater than TLC using ΔPpl with a range of values up to 1.48 litres greater in individual patients. Not surprisingly estimates of TLC in such patients using Ppl lay between lower values obtained from helium dilution and higher values found when Pmo was used.

Frequency of panting

The behaviour of Pmo in relation to Palv in the presence of increased airways resistance is similar to the amplitude and phase changes occurring in voltage when an alternating current is applied across a first order low pass RC filter.

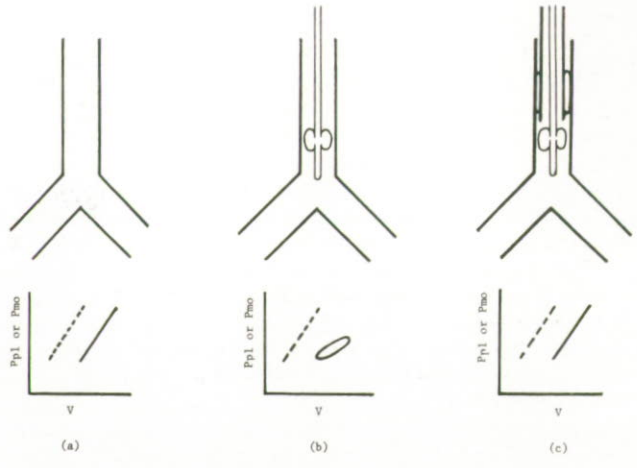

Fig 3. *Adapted from Rodenstein et al*[5].
(a) Subject performing panting manoeuvre with oesophageal balloon (not shown) in place.
(b) Panting manoeuvre as in (a) but with balloon inflated in lower trachea to increase airways resistance.
(c) Panting manoeuvre as in (b) but with endotracheal tube and inflated cuff in place to eliminate the effect of upper airway compliance.
Each panel shows the display of Pmo (continuous lines) and Ppl (dashed lines) against V. Note that in (b) the ΔPmo/ΔV plot is an open loop indicating both attenuation of Pmo and phase lag of Pmo on ΔV. The phasing can only be detected by observing the direction of the looping which is a counter-clockwise motion. Diagram has been drawn as in original study. Similar results would have been obtained using standard Dubois body-box where ΔPbox would have replaced ΔV. In that case slopes of lines would be negative.

Alternating current theory allows accurate predictions of voltage amplitude and phase changes if the frequency and the resistance and capacitance of the circuit are known. Applying this theory to the lung, several models have been developed which accurately predict the behaviour of Pmo in relation to panting frequency and known values of airways resistance and upper airways compliance[7 10]. That both amplitude and phase changes occur in Pmo can be seen from Fig 3b where the plot of Pmo vs Pbox is not only flatter than Ppl vs Pbox but also looped with Pbox leading Pmo.

Shore and colleagues[10] have shown that by lowering the frequency of panting in the body box to about one per second (1 Hz), the amplitude of Pmo swings becomes much closer to the amplitude of Ppl, and hence Palv swings, in patients with chronic airflow obstruction.

As frequency of panting increases so the amplitude of Pmo changes falls in comparison with Ppl. Hence as panting frequency increases the ratio of Pbox/Pmo rises as does Vtg and derived TLC. In this study TLC calculated from Pmo averaged 0.14 (±0.09) litres higher than TLC calculated from Ppl at panting frequencies ranging from 0.5 to 1.0 Hz, but this discrepancy rose to 1.49 (±0.40) at frequencies of 2.5 to 3.0 Hz. A panting frequency of 1 Hz would therefore seem to be optimal for patients with severe chronic airflow obstruction and seems to be one way of avoiding overestimation of Vtg in such patients. Although in the group of patients studied panting at 1 Hz resulted in ΔPmo approaching ΔPpl, there is no way at present of predicting how often this occurs in a given individual since when the measurement is made routinely an oesophageal balloon is not used.

Conclusion

All those using the body plethysmograph for routine measurement of lung volume should be aware of this recent research. The practical implications relate mainly to the use of the body box in measuring TLC and its subdivisions in severe airflow obstruction. If lung volume needs to be assessed accurately for experimental purposes then there would appear to be no alternative to the use of an oesophageal balloon to measure ΔPpl at present. The same arguments apply to the assessment of airways resistance (Raw) in the body plethysmograph, where ΔPmo is used to assess ΔPalv, but this has yet to be examined in detail. A lower panting frequency than is normally used, of approximately 1 Hz seems advisable in patients with severe airflow obstruction.

The body-box no longer occupies the 'gold-standard' position in the measurement of lung volume in disease, and it may be that routine lung function laboratories should examine other alternatives in future. Most promising are the various radiological techniques now simplified by use of small laboratory computers.

References

1. Dubois A D, Bothelho S Y, Bedell G N, Marshall R, Comroe J H (1956). A rapid plethysmographic method for measuring thoracic gas volume: A comparison with a nitrogen washout method for measuring functional residual capacity in normal subjects. J Clin Invest *35* 322-6.
2. Freedman S, Tattersfield A E, Pride N B (1975). Changes in lung mechanics during asthma induced by exercise. J Appl Physiol *38* 974-82.
3. Brown R, Hoppin F G, Ingram R H, Saunders N A, McFadden E R (1978). Influence of abdominal gas on the Boyle's law determination of thoracic gas volume. J Appl Physiol: Respirat Environ Exercise Physiol *44* 469-73.
4. Brown R, Ingram R H, McFadden E R (1978). Problems in the plethysmographic assessment of changes in total lung capacity in asthma. Am Rev Resp Dis *118* 685-92.
5. Habib M P, Engel L A (1978). Influence of the panting technique on the plethysmographic measurement of thoracic gas volume. Am Rev Resp Dis *117* 265-71.
6. Rodenstein D O, Stanescu D C, Francis C (1982). Demonstration of failure of body plethysmography in airways obstruction. J Appl Physiol: Respirat Environ Exercise Physiol *52* 949-54.
7. Stanescu D C, Rodenstein D, Cauberghs M, van de Woestijne K P (1982). Failure of body plethysmography in bronchial asthma. J Appl Physiol: Respirat Environ Exercise Physiol *52* 939-48.
8. Shore S A, Milic-Emili J, Martin J G (1982). Reassessment of body plethysmographic techniques for the measurement of thoracic gas volume in asthmatics. Am Rev Resp Dis *126* 515-20.
9. Rodenstein D O, Stanescu D C (1982). Reassessment of lung volume measurement by helium dilution and by body plethysmography in chronic airflow obstruction. Am Rev Resp Dis *126* 1040-4.
10. Shore S A, Huk O, Mannix S, Martin J G (1983). Effect of panting frequency on the plethysmographic determination of thoracic gas volume in chronic obstructive pulmonary disease. Am Rev Resp Dis *128* 54-9.

CHILDHOOD ASTHMA AND SPORT — A PERSONAL VIEW

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York District Hospital

Introduction

The word 'asthma' is derived from the Greek work meaning 'to pant' and the condition was indeed recognised centuries ago by both Hippocrates and Galen. Prescriptions for its treatment have, in the past, included extracts of fox lung or owl's blood and even today a number of myths surround its causation and treatment.

The management of childhood asthma involves the 'whole child' which means family, friends, doctors and teachers. A large part of a child's life is spent at school and it is vitally important that all concerned should have a similar understanding of the child's specific problems and a rough idea of the implications of the condition and of its treatment. I do not intend to discuss the medical aspects of asthma in detail, but to concentrate on the disorder as it impinges upon school life and recreation.

Attitudes

Attitudes are crucial in the management of childhood asthma. It is true to say that the attitudes of *some* parents, doctors and teachers are unenlightened, restrictive and occasionally dangerous. There are still too many 'weedy rejects', children afraid to strip in changing rooms, who fail to cope with cross country running and a minority who cannot manage even sports like soccer, rugby football, hockey or netball which afford periods of rest. Alan Pascoe, an Olympic Silver Medallist in a speed event, and Chris Drury, a Gold Medallist in rowing, one of the most arduous of all sports, have both told me personally of how they suffered in their early childhood from the stigma of asthma, wheezing and sports failure. One of the crucial ways around this problem is for the doctor (an interested general practitioner or paediatrician) to meet the school teacher or school medical officer or, even better, to participate in some sport along with the children and the teachers. I sometimes play football with a 9 to 11-year-old group from two local primary schools and 'health education' can take place as I recover my breath at half-time!

Physical Exercise

Physical and emotional fitness in childhood asthma are of great importance. Children undergo continuous growth

and development and the asthmatic child should aim to be fitter than the non-asthmatic so that there is greater reserve under stress. Opinions differ, however; at a Symposium in Oslo entitled "The Asthmatic Child in Play and Sport" Alan Pascoe, myself and a few other doctors had just completed a five-mile run to be greeted by an overweight, cigar-smoking colleague who poured scorn on our efforts!

Many children with exercise-induced asthma benefit from pre-medication – that is, the use of an anti-asthma drug before exercise. Inhaled drugs such as salbutamol or 'Intal' are of value and can be taken between 5 and 20 minutes before the exercise period. It seems likely that a longer warm-up period is necessary for the asthmatic, a period of some fifteen minutes in which the child cautiously searches out the physical limits; intervals for rest are of considerable importance.

Fig. 1. *Members of the York asthmatic swimming group with a trophy won at a National Asthmatic Swimmers meeting. The small boy immediately to the left of the boy holding the cup has, in additional to asthma, cystic fibrosis, coeliac disease and pluck!*

The Swimming Group

Why should we use swimming in particular? This is not the only form of exercise suitable for such children but is less likely to provoke exercise-induced asthma than other forms of exercise of comparable intensity. A swimming group for asthmatic children was formed in York in 1977 and between 150 and 200 have passed through the group since then (Figs. 1 and 2). The children are selected from Out-patient departments (their ages range from 3 to 17) and their attendance is always discussed in advance with their family doctors; in any case, we have available at the pool a doctor who knows most of the children already. Recently some brave non-swimming adult asthmatics joined the group, but others are able to swim for their clubs and to do so with distinction.

We hire a local swimming pool every Friday evening: the cost was initially borne by Fisons but the local community has come to our assistance and the whole project is now self-supporting. We originally had two international swimmers who gave up their time to coach the children, but now the coaches are supplied by the families themselves. One of the children has actually swum in exhibition races (two lengths breaststroke) against David Wilkie. The races were usually judged by Alan Pascoe, who on one or two occasions, "misjudged" the handicap so that David Wilkie had to concede defeat, much to the pleasure of the other children. We have broadcast this idea in other cities in the UK and it has been adopted with enthusiasm elsewhere, although we cannot claim to have been the first. The York project owes much to the foresight and energy of of Dr. David Morris, a local family doctor, and to Fisons Ltd.

Fig. 2. *An award for determination.*
L to R: (1) Moira Grainger (swimming teacher).
(2) Richard, a very bad asthmatic despite maximal treatment; he received this award and £100 for effort and determination.
(3) The author.
(4) Dr Morris, York general practitioner and founder of the swimming group.

The Benefits

A number of studies have demonstrated the beneficial effects of training programmes on asthmatic children. Muscle power, posture, lung volume and general fitness can be improved. None of the studies, however, showed any difference in bronchial hyper-reactivity before and after the exercise programme and exercise-induced asthma was likewise unaffected. One must stress, however, that certain asthmatic children do not enjoy, or benefit from, the swimming programme and it is clearly pointless to try to force them to take part. Some of my asthmatic patients have benefited from practising wind instruments or singing while others have derived considerable enjoyment from other

sports such as riding or gymnastics. My impression is that the frequency of hospital admission and of school absence is diminished, though we do not have any figures to back this statistically. Parental attitudes have likewise become more positive and on occasions parents have reached out and helped others who have had anxieties over their children's asthma.

The community aspects are particularly pleasing to me personally. A national review of children's services in this country stressed the importance of doctors working 'in the community' and this swimming group represents one practical method of achieving this. The same spirit should clearly apply to other handicapping conditions such as cystic fibrosis, epilepsy and spasticity and in York many such children also take part in regular swimming.

Conclusion

Asthma still causes considerable unhappiness to children and may prevent their living life to the full. Much of the suffering can be avoided by earlier diagnosis and more skilful use of therapeutic agents. It is not helpful to deny the presence of asthma or to avoid using the word itself in discussions with parents or children. Ideally an asthmatic child should be looked after by one doctor who knows him well and understands the pattern of his disease. This may be impractical and a team approach is sometimes necessary. This will only function well if all members of the team-patients, parents, doctors, teachers and physical training instructors – have a fairly uniform understanding of the treatment aims and a balanced view of the disease process itself.

Acknowledgement

This article has been modified from a publication which originally appeared in "In the Swim", the journal of the Institute of Swimming Teachers and Coaches Ltd; by kind permission of the Editor.

THE LUNGS AND RHEUMATOID ARTHRITIS

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In 1948 Ellman and Ball drew attention to the association between rheumatoid arthritis and lung disease and the term 'Rheumatoid Lung' first appeared. Since that time many lung diseases have been reported to occur more commonly in rheumatoid patients than in the population at large or in control groups. These disorders include pleural disease, pulmonary nodules, rheumatoid pneumoconiosis (Caplan's syndrome), pulmonary infections and fibrosing alveolitis. More recently it has been suggested that airways disease may occur more frequently in the rheumatoid patient.

Rheumatoid arthritis is a common disease affecting approximately 5% of the population and it might be expected that a number of these patients will have lung diseases which are independent of the joint disease. Rheumatoid arthritis is however a systemic disease affecting not only the joints (Fig. 1) but also other organs and connective tissue structures so it would be surprising if pulmonary involvement did not occur in some patients. Unfortunately the term 'rheumatoid lung' is too often loosely attached to any patient with rheumatoid arthritis who has respiratory symptoms or an abnormal chest X-ray, and it would be a mistake to assume that a patient with rheumatoid arthritis who is short of breath or has a cough necessarily has rheumatoid lung disease. The term 'rheumatoid lung' should only be used when it can be shown that the chest symptoms and underlying lung disease are directly associated with the rheumatoid arthritis. This article describes the different types of pulmonary involvement seen in patients with rheumatoid disease.

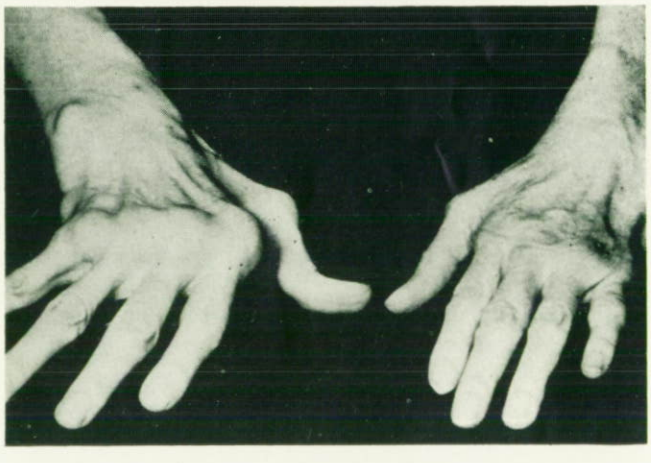

Fig. 1. *Typical appearance of the hands in severe rheumatoid arthritis.*

Pleural Disease

Pleural abnormalities are commonly seen in patients with rheumatoid arthritis and in post mortem studies have been observed in as many as 70% of patients. Patients may present with pleuritic symptoms with or without an effusion but may be symptomless, the only evidence of pleural involvement being a pleural rub. A history of pleurisy is common within five years of onset of joint disease. Effusions when they occur are usually unilateral and are found more frequently in men who have a positive rheumatoid factor. These effusions occur early during the course of the disease and on occasions may precede the onset of the arthritis thus presenting diagnostic difficulties. The effusions may become chronic and result in considerable pleural thickening.

Pleural fluid when aspirated reveals a raised white cell count and eosinophils and elongated multi-nucleated cells may also be present. The glucose concentration in the fluid may be low and the rheumatoid factor test may be positive.

Abnormalities also include a low complement level and a raised lactic dehydrogenase concentration though none of these features are specific for rheumatoid arthritis. When pleural thickening has occurred a pleural biopsy may also be useful, mainly as a diagnostic procedure to exclude tuberculosis or neoplasm. Occasionally the characteristic histology of a rheumatoid nodule may be seen.

A rarer type of pleural involvement is the development of an empyema (pus in the pleural space). This is thought to arise following cavitation and necrosis of a sub-pleural rheumatoid nodule which contributes to the formation of pus, and usually occurs in association with an exacerbation of the arthritis; the pus obtained from the empyema is usually sterile.

Pulmonary Nodules (Fig. 2)

Although these are the best known manifestation of rheumatoid arthritis they are extremely rare. In one series of 516 patients only two had evidence of rheumatoid pulmonary nodules. There is however no disputing the association because of the characteristic histology of the rheumatoid nodule. Once again these nodules occur more frequently in middle-aged sero-positive men. They are often asymptomatic although occasionally may cause haemoptysis or chest pain if the nodules are situated sub-pleurally.

Rheumatoid nodules are usually solitary and tend to occur in the upper and mid-zones. They may however be multiple and may cavitate when it is difficult to differentiate them from a bronchogenic carcinoma. Very rarely pulmonary nodules may antedate the onset of rheumatoid arthritis, resulting in diagnostic difficulty and biopsy may be required to obtain histology.

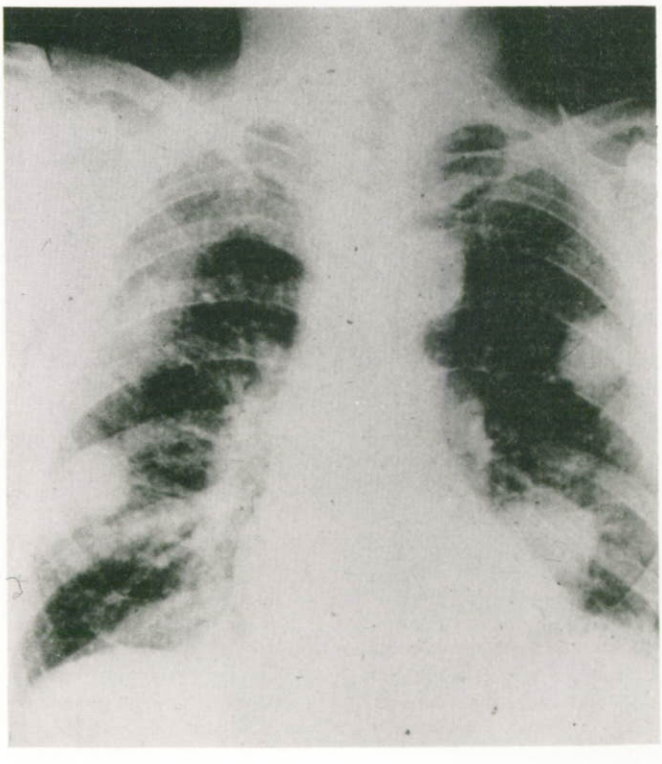

Fig. 2. *Multiple rheumatoid nodules.*

Rheumatoid Pneumoconiosis (Caplan's Syndrome) (Fig. 3)

In 1953 Caplan described a radiographic appearance in coal miners who had rheumatoid arthritis. He subsequently described two separate types of X-ray appearance. The first group had discrete nodular opacities, 0.5-5 cm in diameter, varying from one or two confined to the upper zones to several nodules scattered throughout the lung fields with a background of simple pneumoconiosis. The second group showed mixed nodular and irregular opacities but no background of pneumoconiosis. Similar appearances to those seen in coal miners have also be described in rheumatoid patients exposed to asbestos and to dust in other industries such as iron founding.

In mining communities the overall prevalence of Caplan's syndrome appears to be about 0.25%. One third of patients with radiological abnormalities have clinical rheumatoid arthritis and of those without arthritis 50% have a positive rheumatoid factor. Although the aetiological mechanism for this syndrome is not clear, it seems likely that there are certain genetic factors which make those members of the community who have circulating rheumatoid factor develop pulmonary fibrosis following prolonged exposure to dust.

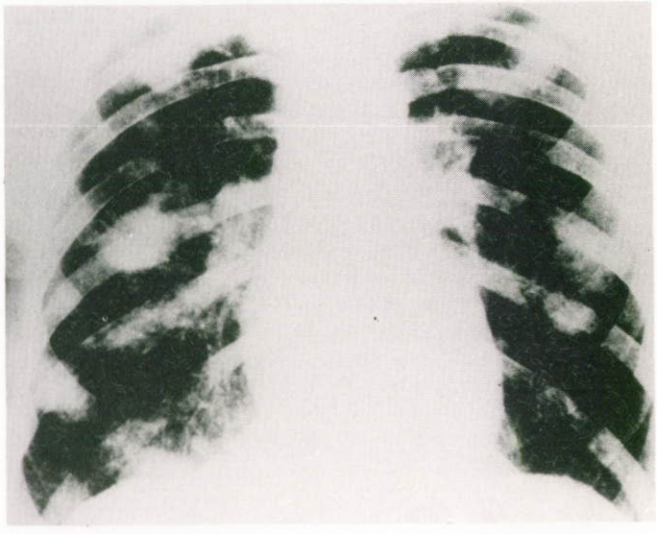

Fig. 3. *Caplan's Syndrome showing nodular opacities on a background of fibrosis.*

Fibrosing Alveolitis (Fig. 4)

The association between fibrosing alveolitis and rheumatoid arthritis was described by Ellman and Ball in 1948. We have to realize, however, that the clinical, radiological, physiological and pathological features of fibrosing alveolitis are identical in patients both with and without rheumatoid arthritis.

In patients with rheumatoid disease alveolitis occurs most commonly in middle-aged men who have a positive rheumatoid factor. They present with increasing breathlessness without cough or sputum. Clubbing of the fingers may be present and basal crepitations are heard on auscultation. Physiologically there is a restrictive defect without obstruction. The FEV_1/VC ratio is normal but total lung capacity is reduced. Gas transfer is impaired and transfer factor is low. The PCO_2 remains normal (Table 1).

Pathology: one of two histological appearances may occur. A desquamative type in which there is minimal thickening of the alveolar walls with collections of intra-alveolar mononuclear inflammatory cells or a mural type in which there is predominantly thickening of the alveolar walls without exudate. Most patients with rheumatoid arthritis have mural thickening.

X-ray appearances tend to be variable. There may be widespread mottling or reticular shadowing which is most marked at the bases. With increasing fibrosis radiographic honeycombing may occur. The diaphragm is high reflecting reduced lung volumes.

Treatment: Fibrosing alveolitis tends to be progressive leading to increasing breathlessness and disability. Treatment of this condition is very difficult and at present no drug regimes have been shown to be helpful. The use of steroids is controversial and most series have found improvement clinically and physiologically in only a minority of patients. It is however usual to give a therapeutic trial of steroids in the hopes of achieving some benefit. Other drugs such as D-penicillamine, cyclophosphamide and azathioprine have been used with only limited success.

Fibrosing alveolitis is a rare disease in the general population. It is however found radiologically in approximately 5% of patients with rheumatoid arthritis. In patients with fibrosing alveolitis rheumatoid arthritis is seen in about 15% of patients and in those patients with fibrosing alveolitis and no arthritis a significant number also have circulating rheumatoid factor. It seems possible that degrees of fibrosing alveolitis which are not apparent clinically or radiologically are more common. This is supported by several studies of respiratory function which show evidence of impaired gas transfer in patients with rheumatoid arthritis. It seems therefore that some degree of pulmonary fibrosis occurs in a significant number of patients with rheumatoid disease.

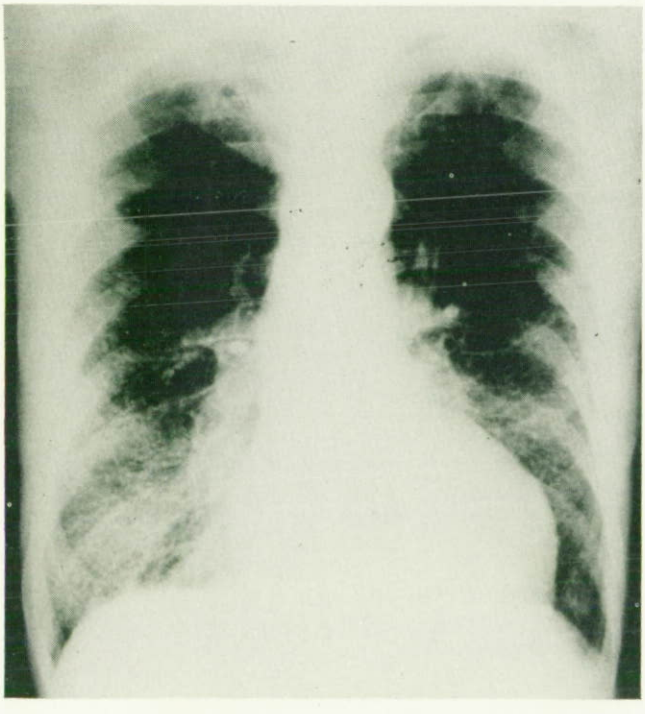

Fig. 4. *Bilateral basal shadowing in fibrosing alveolitis.*

Table 1

Lung function tests in a patient* with rheumatoid arthritis and fibrosing alveolitis

FEV_1 (litres)	1.3	2.0
VC (litres)	1.4	2.6
TLC (litres)	2.2	4.6
Peak expiratory flow (litres/min.)	204	360
CO transfer factor	2.4	7.1

*Female aged 67.

The reasons for this are not entirely clear. It has been shown that there is an increased frequency of the alpha-1 antitrypsin phenotype MZ. The possession of this phenotype is associated with lower levels of alpha-1 antitrypsin and as this is a proteolytic enzyme inhibitor lowered serum levels may well result in increased tissue damage with fibrosis at sites of inflammation. It has also been suggested that large circulating immune complexes formed between rheumatoid factor and immunoglobins might lodge in the capillary bed causing pulmonary capillary damage. This is supported by the finding of deposits of IgM, IgG and rheumatoid factor in the alveolar walls of patients with rheumatoid arthritis and fibrosing alveolitis. Thus it seems likely that this immune complex deposition together with a lowered level of alpha-1 antitrypsin might be the mechanism whereby pulmonary fibrosis occurs in rheumatoid patients. It also seems likely that there are genetic factors which make some patients more susceptible to this form of lung damage.

Pulmonary Infection and Airways Disease

Respiratory infections including *bronchitis, pneumonia* and *bronchiectasis* are all more common in patients with rheumatoid arthritis than in the general population. In one large series of of 516 patients, 28% of men and 20% of women gave a history of pneumonia, most of these infections antedating the onset of the arthritis. In the same series an increased incidence of bronchiectasis was found. Other studies have shown an increased incidence of bronchitis in rheumatoid patients and studies of lung function have frequently shown evidence of airways obstruction. A number of workers have attributed airways disease to smoking in rheumatoid patients but more recently it has been shown that airways obstruction in rheumatoid patients is independent of smoking. Also airways obstruction in rheumatoid smokers is more severe than in control groups. In one recent study 32% of patients with rheumatoid arthritis were found to have significant evidence of airways obstruction, all these patients having normal chest X-rays. It was concluded that airways obstruction may be very common in patients with rheumatoid disease.

Bronchiolitis obliterans, has recently been described in a few patients with rheumatoid arthritis. Bronchiolitis obliterans is a rare condition which usually occurs in childhood following viral infection but has occasionally been seen in adults following inhalation of chemical fumes. It is characterised by rapid onset of breathlessness that progresses to respiratory failure or death. On auscultation loud crackles are heard together with a high pitched mid-inspiratory squeak. The chest X-ray remains normal or shows evidence of hyperinflation, whereas lung function studies show airways obstruction or air trapping. This combination suggests intrinsic airways disease. Bronchograms when done show widespread filling defects of the peripheral airways and histology shows obliteration of the bronchioles with an inflammatory exudate. Although initial reports suggested a relationship with penicillamine therapy, cases have now been seen who have not been taking this drug.

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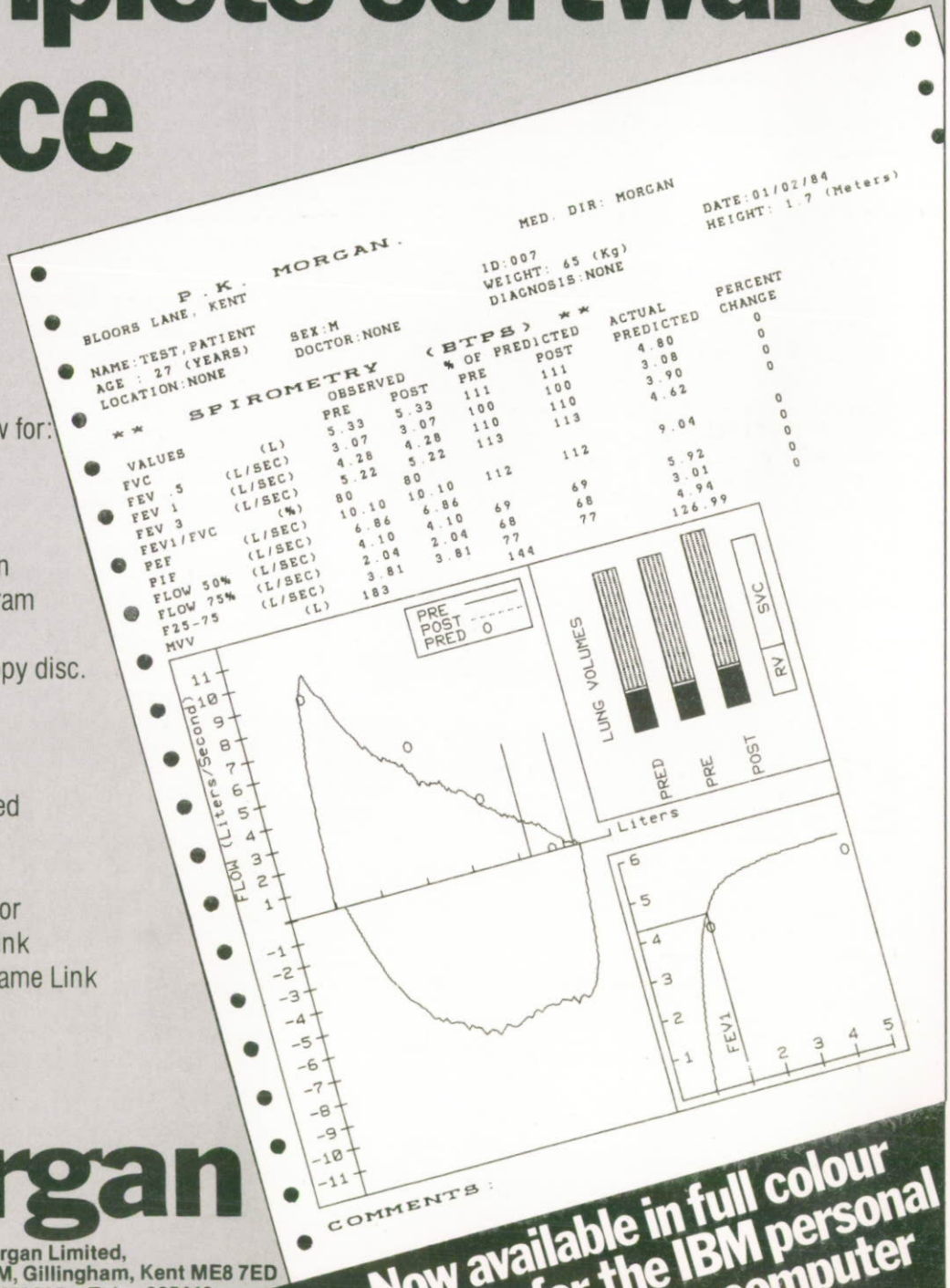

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Airways disease in some form is therefore often found in patients with rheumatoid arthritis. One possible explanation is that it is secondary to repeated respiratory infections. The evidence suggests that patients with rheumatoid arthritis have an increase susceptibility to airways infections or a reduced inability to control or eradicate them. This tendency might then be evident clinically as either bronchiectasis or progressive airways disease. Interestingly, many of these infections appear to antedate the onset of the arthritis and as there has been much speculation about the initiating role of infective agents in the pathogenesis of rheumatoid arthritis, it is tempting to hypothesise that respiratory pathogens may play an important role in triggering the disease in patients who are perhaps genetically predisposed.

Anti-Rheumatic Drugs

Many of the drugs given to patients with rheumatoid arthritis may be responsible for breathlessness. Most non-steroidal anti-inflammatory drugs are potent prostaglandin synthetase inhibitors and must therefore be used with great care in patients with a history of asthma as they might precipitate an attack. Rarely, they may cause wheezing in patients with no history of asthma. Many of these drugs also cause fluid retention and might be responsible for the production of pulmonary oedema and left ventricular failure.

Gold salts may cause either progressive pulmonary fibrosis or an acute allergic alveolitis. Both of these are reversible on stopping the drug. Similar side effects have also been reported following treatment with D-penicillamine. It must also be remembered that patients with rheumatoid arthritis have other generalised diseases and might be taking drugs which could cause pulmonary symptoms.

Conclusion

Several lung diseases are associated with rheumatoid arthritis. Some of these, in particular pulmonary nodules, occur as a result of the systemic nature of the disease. Reasons for the others are less well understood. It does seem possible that numerous and intercurrent bacterial and viral respiratory infections might trigger the production of antibodies in genetically predisposed individuals with consequent pulmonary damage.

References

1. Ellman P, R E (1948). Rheumatoid disease with joint and pulmonary manifestations. Br Med J *2* 1816-20.
2. Caplan A (1953). Certain unusual radiological appearances in the chest of coalminers suffering from rheumatoid arthritis. Thorax *8* 29-37.

ARTP News

Congratulations are due to Jay Lamb from Derby for passing her HTEC examinations and to the following members for passing their OTEC; Tracey Murray from Sheffield, Jacky Peel from Derby and Gail Slade from London.

British Journal of Diseases of the Chest

It was most gratifying to see that the ARTP was chosen as the subject for an Editorial in the British Journal of Diseases of the Chest. The Editor, Dr. Duncan Empey, commented favourably on the activities of the Association and on the contributions made by technical staff to patient care.

The majority of physicians in the specialty of Thoracic Medicine receive the Journal and the secretary has already had letters from physicians asking for details of the Association to pass on to their technical staff or asking for advice on Technical Qualifications and grading. The Editorial can only improve recruitment and help to gain wider recognition for the ARTP.

Correspondence

A Register of Computer Programs.

I propose the setting up of a "Central Register of Computer Programs in Respiratory Medicine". This would be a list of computer programs provided voluntarily by centres involved in any respiratory field. A small contribution would be paid by the borrower direct to the centre providing the programs. This list would contain the program title, a short description of its applications, the hardware necessary to be able to run the program, the address of the centre at which the program was developed and the name of the contact and/or programmer at that centre. The intention would be to include commercially available software and hardware packages, depending on the ultimate size of the register. Any departments interested in participating in this please contact me at the address below.

Papworth is prepared to start the ball rolling by placing some useful Apple based programs on the register.

John Griffiths
Respiratory Physiology Department,
Papworth Hospital,
Papworth Everard,
Cambridgeshire.

Breath is the journal of the Association of Respiratory Technicians and Physiologists. Original articles, reviews, correspondence or comment on subjects of scientific or general interest may be submitted to the Editor: D C S Hutchison, Chest Unit, King's College Hospital, London SE5 8RX. Material should preferably be typed on one side of the paper only, in treble spacing throughout. Photographs should be of good contrast, printed on glossy paper and unmounted. Tables and legends to figures should be typed on separate sheets.

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