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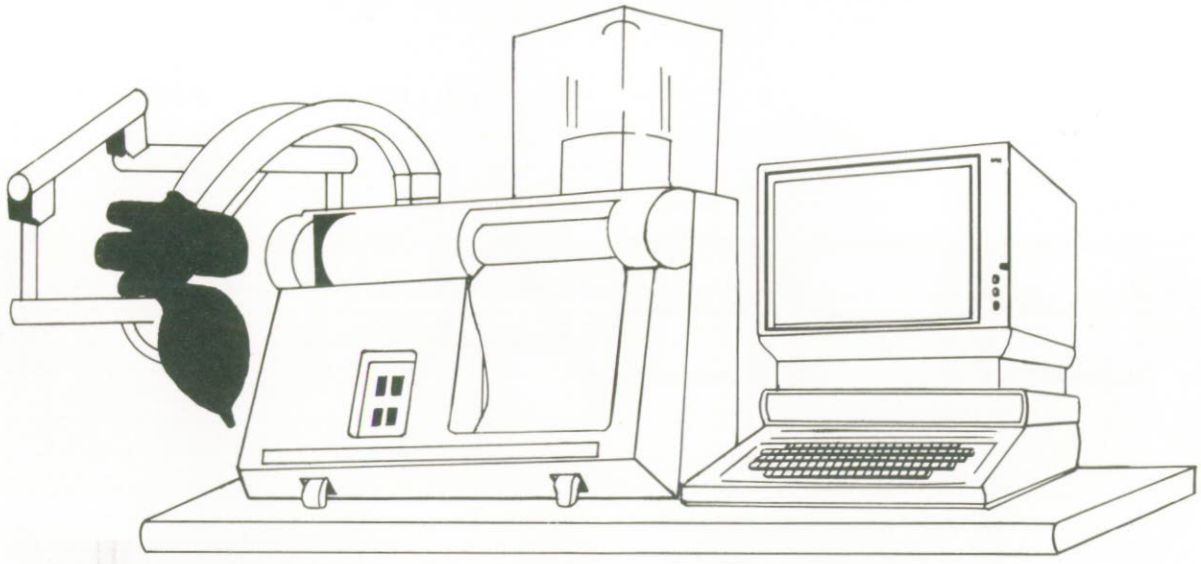

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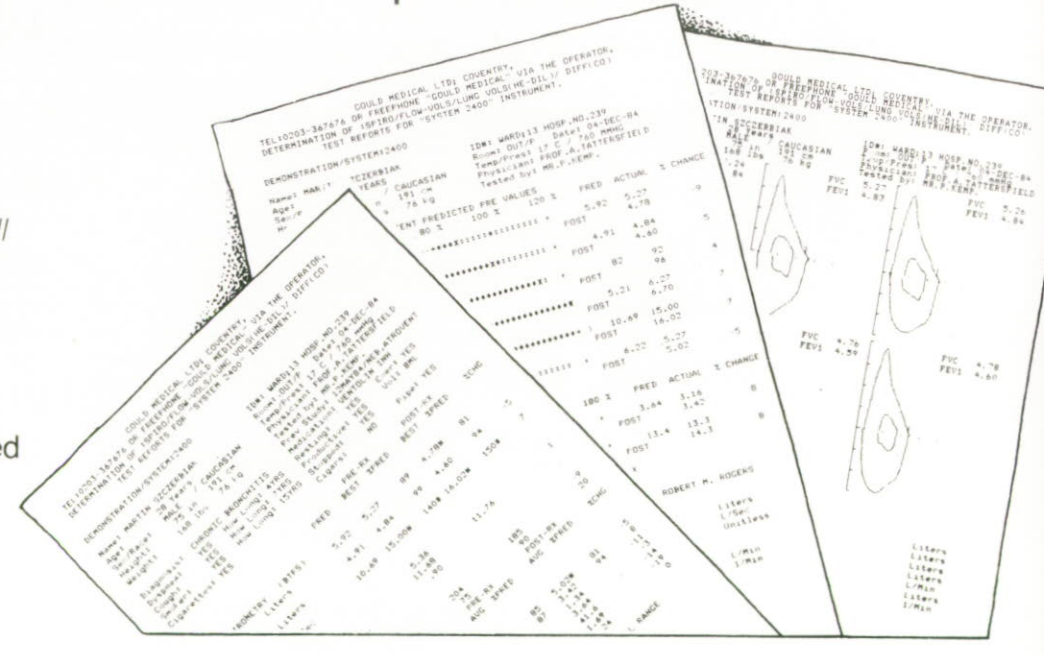

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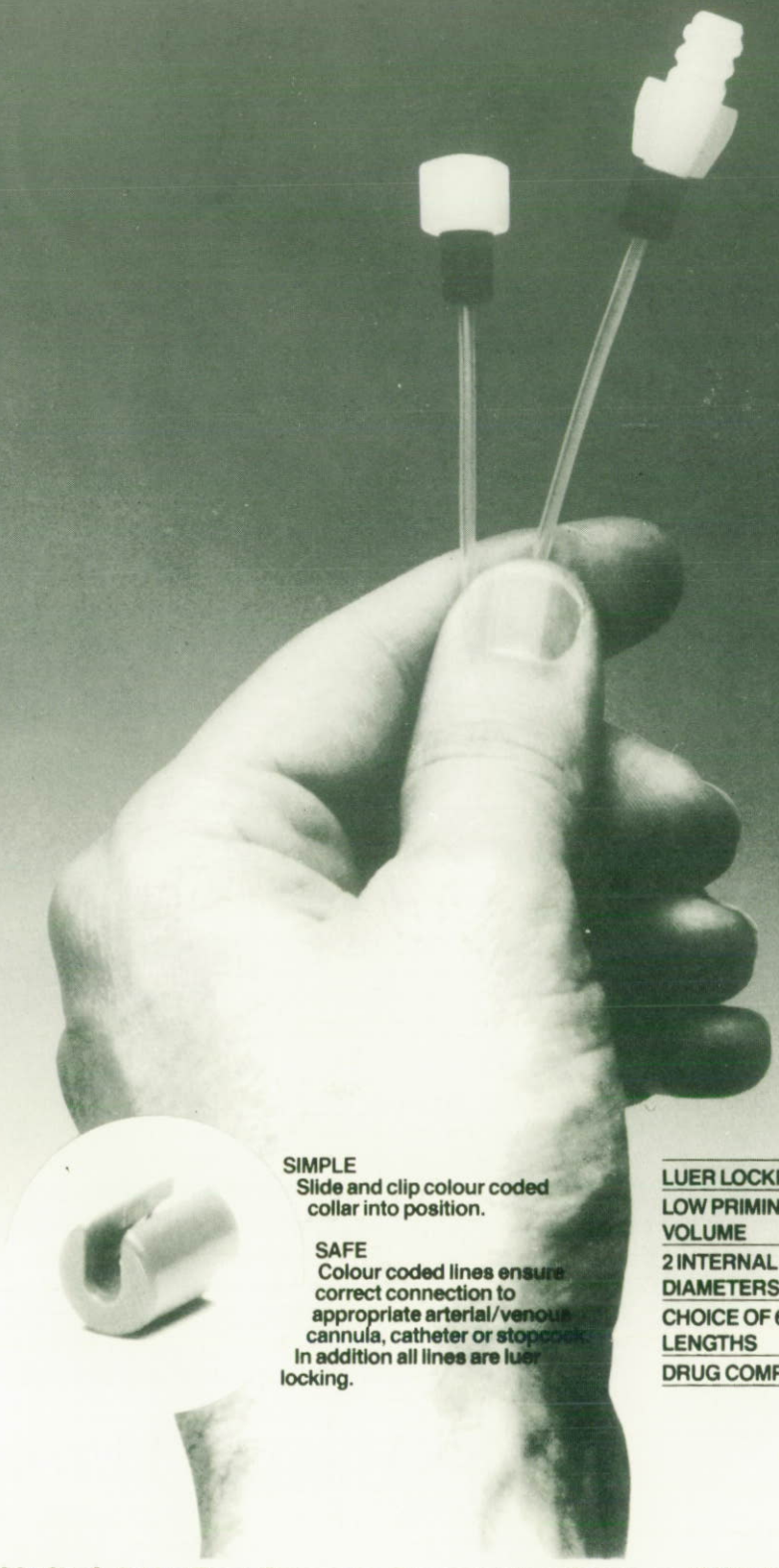

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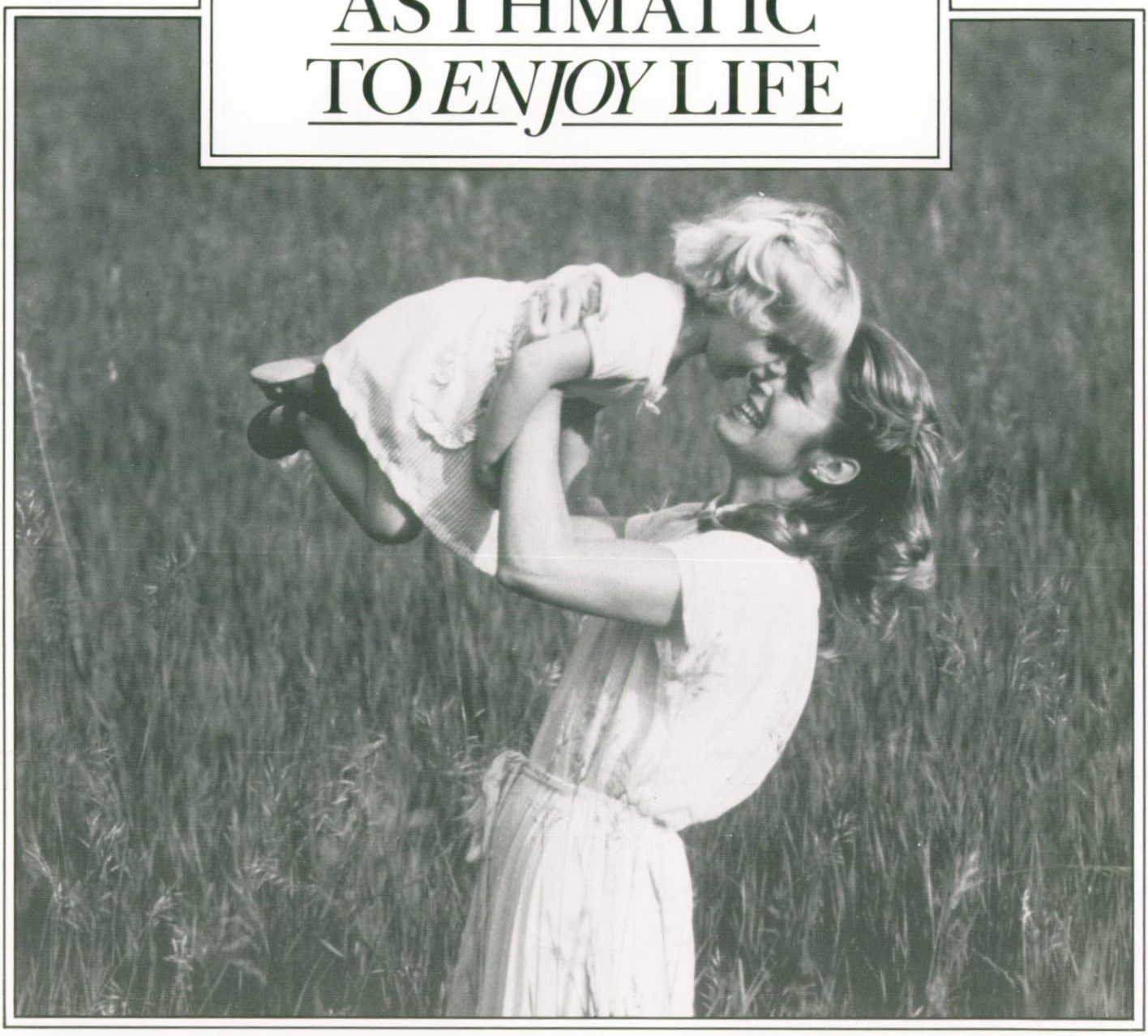

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EDITORIAL

Research Concern

Few members of the technical staff in respiratory departments, especially in the larger centres, will not have taken part in some kind of research project and some may even have been employed on a specific research grant. Participating in research at any level ought to be a useful and rewarding experience and a great many science degree courses now include a period during which the students are expected to work on projects of their own in which they plan and execute the experimental work, review the relevant literature and submit a detailed report. This is a refreshing idea in today's examination-dominated world where the emphasis is so often on the repetition of remembered knowledge, without any measure of that ability to generate original ideas without which research in any real sense is impossible.

Many now entering the technical professions already hold a basic science degree and may be planning or already undertaking a further course of study or research. While we are not in the near future likely to see an all-graduate technical profession, a trend in this direction is taking place and is likely to continue. Employees in any section of the health care industry and more especially in university departments may be required to undertake a mixture of research, teaching and service to patients. This commitment has been likened to a "three-legged stool", a somewhat inappropriate simile since the far more important research component quite clearly dictates the direction in which the other two will go; without research we neither know what to teach our students or how to care for our patients.

What is research? Looking for a formal definition is likely to prove tedious but in practice the word is commonly used to indicate a systematic enquiry into any scientific field, whether nor not this results in new or even truthful answers! It is customary to distinguish "basic" research like the discovery of X-rays, from "applied" research on the uses of X-rays in medicine and industry. There may be a time lag of many years between a basic discovery and any useful application and it may be impossible to forecast at the time whether any value will come of the basic research.

The financial rewards for individuals undertaking research are generally not great in relation to the effort expended. The financial requirements on the other hand may be very large indeed and research workers have for many years bemoaned the time they have to spend on actually raising the money necessary for starting the work they wish to do; the furtherance of knowledge thus depends very largely on the effort which individual researchers are prepared to put into their fund-raising activities, though large funds do not of course necessarily mean good research. It is an unfortunate truth that, in today's financial climate, the grant application may require as much time and effort as the research itself.

The largest fraction of any grant application is likely to be devoted to salaries. The majority of applications are for project grants intended to fund research for three years, the time during which supposedly the research worker should reach a worthwhile conclusion. Let us assume that the research worker's salary, based on age, qualifications and experience has been calculated at £10,000. It is then necessary to add a further 20% to cover superannuation and national insurance, and with a further sum for consumables and minor items of equipment, we soon reach a total of £40,000 for the three year project. A medium term five year project, requiring say two salaried research workers (a scientist and a technician perhaps) could easily reach six figures at today's prices. Which is where one's problems begin!

The limitations of the possible sources of finance have been outlined in a valuable review by Dr. Malcolm Green (1). The Medical Research Council (MRC), the largest single source of Government funds for reearch, has in its Annual Report (2) expressed "grave concern" over the inadequacy of the resources made available to it; this has in fact been a prominent theme of its reports for the past decade and more. The Council points out that the recent niggardly increases in their grant fall short of the rate of inflation so that "the opportunities presented by biomedical research cannot be exploited". The damage so occasioned could clearly be carried forward over the next quarter century, or well within the working life span of those now entering professional employment.

The MRC last year received a total grant of about £120 million to fund all of its activities. Much of this goes to finance its own units, in particular the two large establishments, the National Institute for Medical Research at Mill Hill and the Clinical Research Centre (CRC), at Northwick Park, which each take about £10 million per year. The CRC has had problems in fulfilling its potential as a research centre, apparently due to lack of coordination between NHS and academic staff (3); it seems therefore that the CRC must either close or amalgamate with the Royal Postgraduate Medical School at the Hammersmith Hospital, a union one views with some trepidation. Some economic savings might thus arise and one hopes that some of this will be allocated to research in the respiratory field. The published accounts of the MRC indicate that £867,000 was spent on projects which were primarily classified as respiratory, though the figure can be inflated considerably by including other projects in which there is a respiratory component, such as those involving occupational or environmental hazards.

It has been argued (1) that funds for medical research should logically be allocated according to economic cost; in this case respiratory disease should do very well since it accounts for about 20% of all deaths in the UK. Dr. Green and other respiratory physicians have therefore taken the imaginative step of forming a completely new medical charity, called the British Lung Foundation which will be concerned with raising funds for research into respiratory disease alone and we can only wish this venture the very best of fortune. Nevertheless and in spite of these commendable efforts, one does not have to be a pessimist to view the future state of British research with some foreboding.

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COMPUTERISED DETERMINATION OF CARDIAC OUTPUT BY MASS SPECTROMETRY

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Abstract

A computer programme written in MINC-BASIC (V 1.1) has been developed, using a DEC-MINC 11/03 system, to give a non-invasive determination of cardiac output. The method incorporates both data acquisition and real time analysis, instead of previous analysis of polygraph readings, making the method practical for routine clinical use. The programme is flexible, allowing operator-interaction in controlling the experiment and reviewing the collected data for any experimental or physiological artefact prior to final analysis. The computer system calculates changes in gas concentrations, blood carbon dioxide solubility and alveolar volume (by argon dilution) to obtain a non-invasive determination of cardiac output.

Introduction

To determine cardiac output by direct methods, invasive arterial catheterisation is required. Numerous non-invasive methods have been documented which are less hazardous, and technically less demanding. This paper describes a nethod for calculating cardiac output from one such technique (1) using an interactive computer programme.

Theoretical Background

The Winsborough CO_2 rebreathing method (1) for determination of cardiac output is one application of the Fick principle (2), which states that flow can be calculated from the uptake or removal of a component of blood and its arterial-venous content difference. For CO_2 and pulmonary blood flow the Fick principle may be written:

$$Q = VCO_2/(CvCO_2 - CaCO_2) \qquad \textit{(Equation 1)}$$

where Q is the cardiac output, VCO_2 is the carbon dioxide output, $CvCO_2$ is the mixed venous CO_2 content and $CaCO_2$ is the arterial CO_2 content.

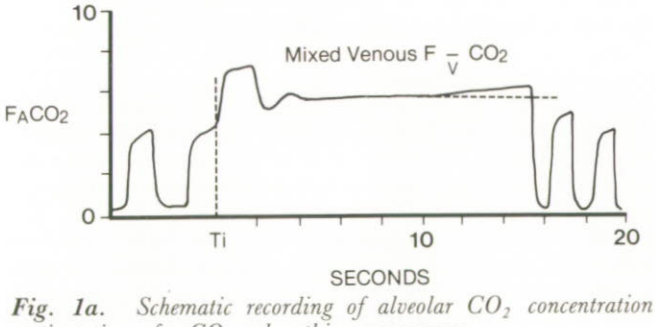

Fig. 1a. *Schematic recording of alveolar CO_2 concentration against time, for CO_2 rebreathing manoeuvre.*

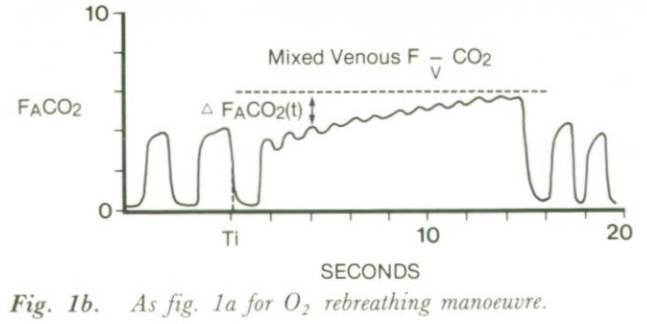

Fig. 1b. *As fig. 1a for O_2 rebreathing manoeuvre.*

The Winsborough method employs a CO_2 and an O_2 'rebreathe'. For the 'CO_2 rebreathe' the patient fully inspires a gas mixture containing CO_2 and then rapidly respires to and from a closed bag until a plateau is obtained, indicating equilibrium of CO_2 between the mixed venous blood and alveolar gas (fig. 1a). The mixed venous CO_2 concentration can be calculated from this rebreathing manoeuvre (3). During the oxygen rebreathe (4), a CO_2 free gas is inspired and then rebreathed at an increased rate and depth of breathing for 10-15 seconds (fig. 1b). Measurements may be made at rest and during exercise using the apparatus shown in fig. 2.

From this data a differential mass flow equation can be used to describe the rate of change of alveolar gas concentrations by the addition of CO_2 from the pulmonary blood flow. This implies a mono-exponential rise, with time, of alveolar CO_2 concentration (F_ACO_2) asymptotically towards the mixed venous CO_2 concentration ($FvCO_2$). Hence, the differences between the plateau of the mixed venous concentration and the peak values of the mono-exponential rise can be calculated as follows:

$$\Delta F_ACO_2(t) = FvCO_2 - F_ACO_2(t) \qquad \textit{(Equation 2)}$$

where $\Delta F_ACO_2(t)$ is the change in fractional concentration of alveolar CO_2 at time t, $FvCO_2$ is the fractional concentration of mixed venous CO_2 and $F_ACO_2(t)$ is the fractional concentration of alveolar CO_2 at time t.

A semi-logarithmic graph is obtained (fig. 3). The best straight line (least squares linear regression) can be drawn through the data points and extrapolated back to the intercept on the ordinate line at time T_O which is defined as the midtime through the initial inspiration that began at Ti. The intercept on the y-axis and the slope of the line can be calculated from:

$$\text{Intercept} = \ln[FvCO_2 - F_ACO_2)t_O)] \qquad \textit{(Equation 3)}$$

$$\text{Slope} = \ln\left[\frac{FvCO_2 - F_ACO_2(t_O)}{FvCO_2 - F_ACO_2(t_r)}\right] \times \frac{1}{t_r} \qquad \textit{(Equation 4)}$$

where t_r is the rebreathing time.

The cardiac output Q (litres/min) is obtained from:

$$Q = \frac{V_A \times \lambda \times \text{slope} \times 60}{\alpha bL \times (Pb - 47)} \qquad \textit{(Equation 5)}$$

where V_A is the alveolar volume, Pb is the barometric pressure (mm Hg), 47 is the saturated vapour pressure of water at 37°C, 60 is the conversion factor from sec to min, α(bl) is the solubility coefficient of CO_2 in blood and λ is a correction for the CO_2 binding power of the "lung tissue and static pulmonary blood" and is a function of the intercept of this semi-logarithmic graph (1).

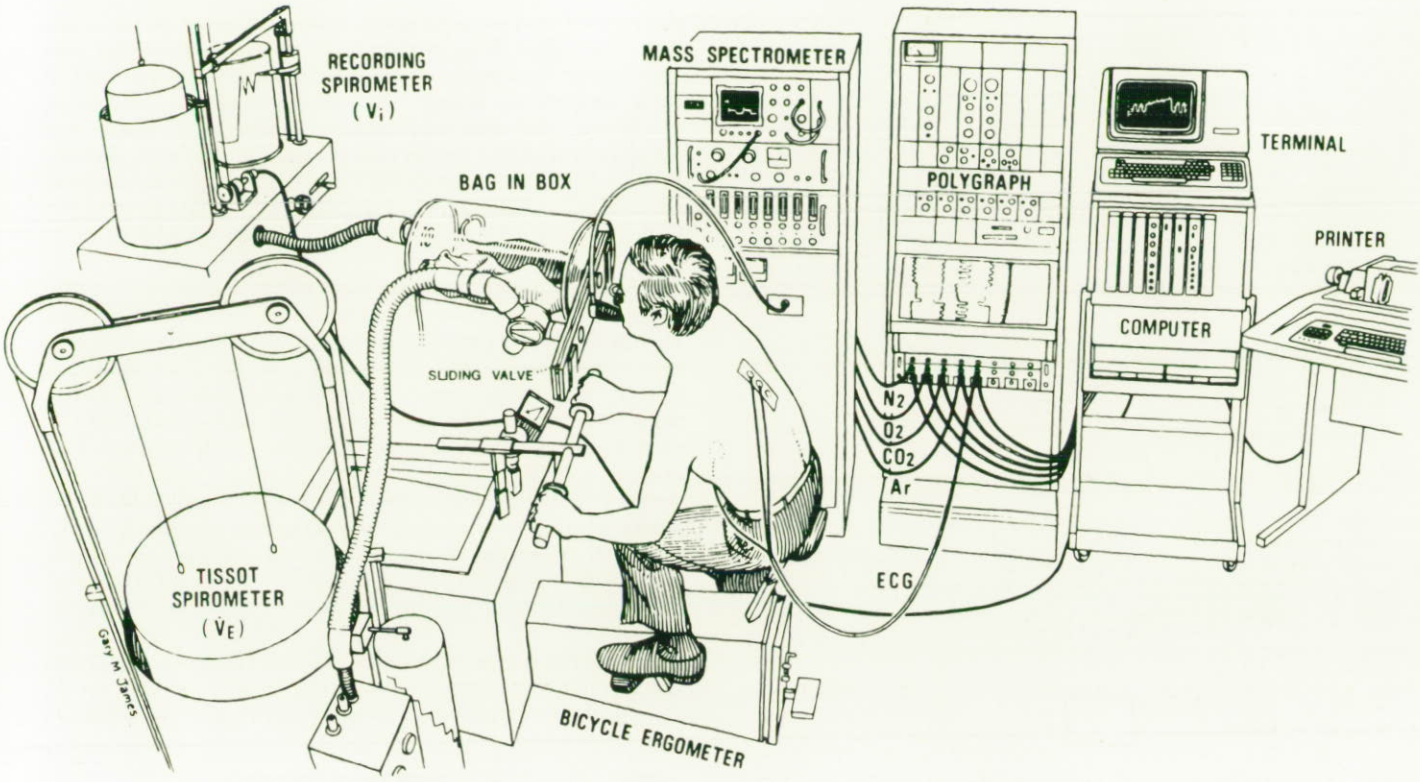

Fig. 2. Apparatus and experimental layout used to obtain computerised non-invasive determinations of cardiac output.

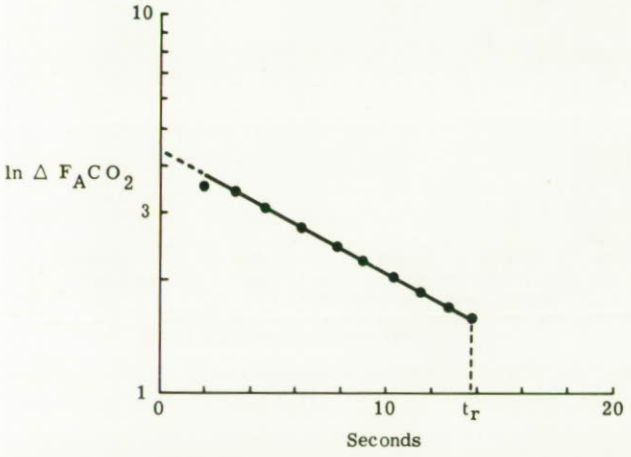

Fig. 3. Semi-logarithmic plot of F_ACO_2 against time. t_r is the rebreathing time.

System Requirements

1. Interface to the mass spectrometer for gas analysis (nitrogen, oxygen, argon and carbon dioxide). The gas concentrations are summed to 100% to give effectively dry gas concentrations. This allows for small fluctuations in the mass spectrometer's sensitivity arising from water vapour present in the expired gas.

2. Alveolar volume (V_A) to be estimated by argon dilution.

3. A fifth channel open to the computer for the recording spirometer attached to the rebreathing bags to give changes in lung volume.

4. The ability to compensate for the phase difference between the mass spectrometer and recording spirometer data acquisition, which is of the order of 0.2 sec.

5. Calculation of CO_2 solubility in blood from standard values of blood parameters or by analysis of earprick blood samples (5).

6. A "user-friendly" system to enable non-technical staff to control the procedure and review the numerical parameters and graphical displays.

Hardware and Software

The changes in gas concentration were analysed by a Centronic Q806 mass spectrometer. Four channels from the mass spectrometer and a fifth channel from the recording spirometer were interfaced with a MINC 11-03 computer, which had a 32kB memory together with a 12-bit analogue to digital converter, clock module and dual floppy disc drives. The programme was written in MINC-BASIC (V1.1), with five interlinked modules (I-V) (fig. 4). The modules perform keyboard and instrument data acquisition, calibration, and the calculations. There is an optional routine (III) for mixed expired gas analysis which is used for other metabolic studies and as a comparative method for cardiac output determinations. To facilitate the identification of parameters, such as peak values, five-point moving cursor techniques were used for smoothing and the differentiation of data (6).

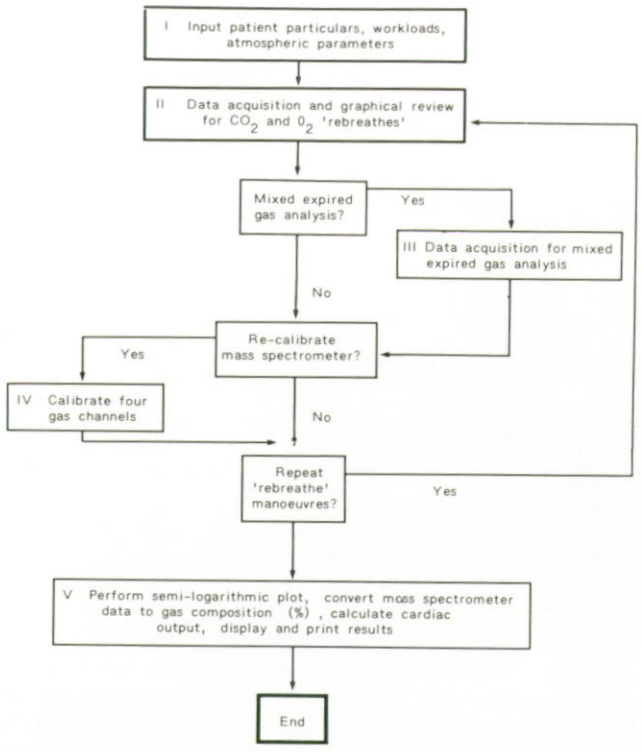

Fig. 4. *Simplified flow diagram of the Basic programmes, which are in the form of five 'chained' modules (I – V).*

Operation interaction was via a LA36 printer and a VT105 visual display unit (VDU), with results being stored on RX02 floppy discs. The graphical displays of the CO_2 and the O_2 rebreathe (figs 5a and 5b) were obtained from the VDU display by a Tektronics hard copier.

Sample Run

Calibration of the mass spectrometer was first carried out by sampling six gas bottles containing different known concentrations of the four gases under analysis. Each gas was sampled at 15 Hz for 6 sec after which a 'least squares fit' gave an algorithm for gas concentration against mass spectrometer channel voltage. Viewing on the VDU of gas bottle concentrations and gas channel correlation coefficients allows for ease of gas sample changes and recalibration when appropriate.

For the "CO_2 rebreathe", at the end of a normal expiration, the subject inspired a gas mixture (40% O_2, balance N_2) primed with a CO_2 concentration which was slightly higher than the expected $FvCO_2$ and then rebreathed (45 breaths/min) until a classical 'plateau' (3) had been achieved, with the fractional alveolar concentration being monitored at the lips by the mass spectrometer sampling at 20 Hz for 20 sec (fig 5a). If the operator was satisfied with the graph displayed, the plateau limits were defined from the time markers in seconds on the VDU so that the operator could exclude rising CO_2 due to blood recirculation.

For the "O_2 rebreathe", the subject fully inspired a CO_2-free gas mixture (40% O_2, 50% N_2, 10% A) and then quickly rebreathed in the closed bag system. The VDU displayed the graph of the CO_2 concentration against time, showing the position of T_O (fig. 5b). Differentiation, by a five-point moving cursor technique was employed to identify the peaks of the CO_2 changes while rebreathing. However, parallel changes in lung volume as given by the spirometer are better suited for initial analysis (fig. 6), than the noisier and smaller magnitude of change of the CO_2 data. The time delay between the mass spectrometer and spirometer data acquisition was found by comparison of their respective traces. By analysis of the changing gradients, the end expiration of the CO_2 data was compared with the initial rise of lung volume with the difference being the time delay. The value T_O, was taken as the midpoint between the lung volume initial rise and the first lung volume peak with the time delay added.

The troughs on the volume data were identified from the negative gradient change to positive. A window of 0.25 sec was then placed over the CO_2 data at the times the volume troughs occurred after adding on the time delay. A five-point moving cursor with centre-weighted smoothing, then scanned the window to find the CO_2 peak and the time it occurred. Each peak time was given on the VDU and the operator asked if he was "happy" with the computer's choice, allowing the operator to reject later CO_2 peaks which are less prominent and less reliable for later analysis. A similar form of analysis occurs on the argon data to calculate alveolar volume by argon dilution and hence the alveolar volume V_A at the time of rebreathing.

If the operator was satisfied with both rebreathes and did not require the option of repeating either, then by use of the calibration algorithms derived earlier, the digitised gas

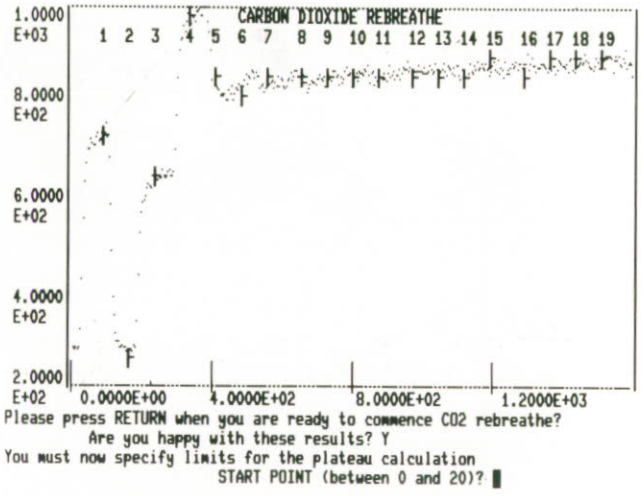

Fig. 5a. *Alveolar CO_2 concentration reaching a plateau during a CO_2 rebreathe.*

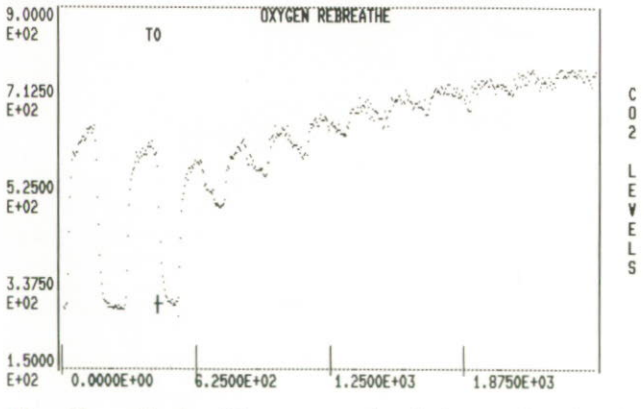

Fig. 5b. *Alveolar CO_2 concentration during an O_2 rebreathe.*
Peak No. 1 after 2.6 secs. (Y or N)? Y
Peak No. 2 after 3.6 secs. (Y or N)? Y
Peak No. 3 after 4.6 secs. (Y or N)? Y
Peak No. 4 after 5.64 secs. (Y or N)? N

parameters selected (such as the plateau and peaks) were converted to percentages, after the four gas channels analysed had been summed to 100%. A least squares fit was applied to the semi-logarithmic plot from which the slope and intercept were calculated. The operator was asked whether blood from an ear-prick had been analysed, and if so, the blood parameters were entered. If not, available standard values were calculated, after which the computer estimated the solubility of CO_2 in blood by Godfrey's method[5]. Cardiac output was then determined and the results given on the VDU and the printer.

Worked Example

Data was obtained from a healthy male subject exercising on a cycle ergometer at 50 watts. Values of $FvCO_2$ and F_ACO_2 were obtained from figs. 5a and 5b. The data is given in Table 1.

Table 1. Results from the CO_2 and O_2 rebreathe manoeuvres.

Rebreathe	Factor	Time (sec)	Carbon Dioxide (% of gas volume)	$FvCO_2 - F_ACO_2$
CO_2	Plateau	—	9.25	—
O_2	1st peak	2.60	4.60	4.65
	2nd peak	3.60	5.05	4.20
	3rd peak	4.60	5.30	3.95
	4th peak	5.64	5.75	3.50
	5th peak	6.60	6.00	3.25
	6th peak	7.60	6.25	3.00
	7th peak	8.70	6.55	2.70
	8th peak	9.70	6.75	2.50
	9th peak	10.70	6.95	2.30
	10th peak	11.70	7.15	2.10

PB = 745 mmHg α(bl) = 0.004
λ = 1.13 Slope = 0.072
Intercept = 5.75% Relative Humidity = 20.5%
Temp = 22.5°C V_A = 4.68 litres STPD

A semi-logarithmic graph was constructed (similar to fig. 3) and a least squares linear regression fit applied. From this the intercept at T_O and the slope were calculated. λ was calculated according to Winsborough et al (1). The alveolar volume was obtained from the summation of the residual volume and the inspired volume during the rebreathes, and corrected to STPD. α(bl) was calculated according to Godfrey (5). The time of rebreathing (T_r) was 11.7 sec.

Thus, from equation 5:

$$Q = \frac{4.68 \times 1.13 \times 0.072 \times 60}{0.004 \times (745 - 47)} = 8.2 \text{ litres/min.}$$

Discussion

At every stage of the development, results were compared between the computer and the formerly used manual graphical analysis of simultaneous polygraph recordings. Repeatability is better and accuracy is improved, the computer system being quicker and thus enabling more tests to be performed by fewer people with less effort. The immediate reporting of results is a further considerable advantage in this type of clinical situation. BASIC, although a slow programming language, is acceptable here since the rebreathing manoeuvres are only performed every few minutes, when the subject had achieved a metabolic "steady-state" at any particular workload.

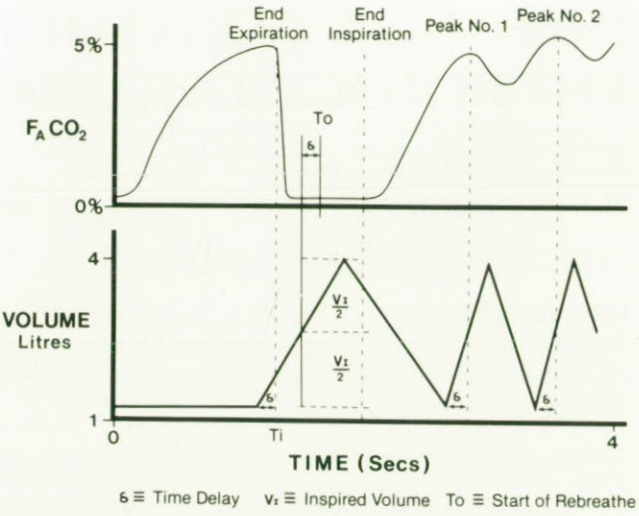

Fig. 6. Schematic detail of changes in the CO_2 concentration and lung volume during an O_2 rebreathe.

A mass spectrometer was used in preference to discrete gas analysers because of its fast response and the small volume of sample. Sampling at 20 ml/min means that there is negligible effect on lung volume measurements.

The results of cardiac output obtained were found to agree with those derived by previous analysis of polygraph readings and are in the expected range for the subject's age, sex, state of health and exercise workload. This computerised method now enables the non-invasive determination of cardiac output during exercise to be performed routinely in any well-equipped pulmonary function laboratory.

Acknowledgements

We would like to thank the Medical Illustration departments of Bristol Royal Infirmary and Frenchay Hospital, who kindly prepared the illustrations.

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This work was presented at the Fourth Congress of the European Federation of Medical Informatics, Dublin, 1982, and has been published in part in an MSc thesis.

INFECTION CONTROL IN RESPIRATORY PHYSIOLOGY DEPARTMENTS

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Introduction

The transmission of respiratory pathogens via respiratory function testing (RFT) equipment has not been fully established (1-3). The possible risks are however well recognized, particularly in those patients with immuno-deficiency disorders or on immuno-suppressive treatment, where recurrent acute or chronic respiratory tract infections are a significant cause of morbidity and mortality (4). Micro-organisms have been cultured from regularly used RFT equipment (3,5-7), but as yet no reports have directly associated RFT equipment with the transmission of infection.

Unlike RFT equipment, which does not generate aerosols, the use of nebulisers (large or small volume) poses potentially greater risks of infection. Large volume devices have been shown to have an important role in the pathogenesis of hospital associated pneumonia (8) and have been associated with numerous outbreaks of nosocomial disease (9-11). Small volume nebulisers are being used increasingly both in respiratory departments and for domiciliary use. There is no direct evidence as yet that these devices are responsible for the acquisition of infecting organisms although bacterial cultures of non-pathogenic organisms have been shown to be frequently positive(12).

Another potential source of infection arises during the course of blood gas analysis where the staff should employ particular caution when handling blood, used syringes and needles. Needle-stick injuries have been reported to account for a large number of work related accidents(13). Although other infections have been reported to be transmitted by accidential needle-stick injuries, hepatitis B and non-A, non-B hepatitis pose the greatest risks. In the absence of immunoprophylaxis, the risk of acquiring overt hepatitis B due to an accidential puncture wound from a needle used on a hepatitis antigen positive patient is about 6% (14). However, a later UK study (15) showed that post-exposure prophylaxis with specific hepatitis B immunoglobulin is highly effective at reducing the incidence of hepatitis B infection. Apart from needle-stick injuries, there have also been reports of infections resulting from contaminated equipment used for collecting and analysing blood samples(16,17).

We have reviewed the likely pathogens which may be found in respiratory departments, and the various methods of killing them. Finally, although there is insufficient data to suggest a relationship between RFT equipment and patient infection, we provide general recommendations for infection control, based on data from various sources (18-21). The application of these recommendations should be determined on an individual basis by each laboratory.

Micro-Organisms

Micro-organisms may be essentially classified into four major groups — protozoa, fungi, bacteria and viruses, each group being composed of large number of diverse subgroups. Protozoa are generally not a problem in respiratory departments, and will not be considered further. A brief review of the characteristics of each group may be found in Elder and Sauer (2). Routine microbiological monitoring of the laboratory and its equipment is neither realistic nor cost effective but there is clearly a need for microbiological assessment of the potential role of transmission of infections via RFT equipment. If and when any studies are carried out, it is important that they are directed and guided by the appropriate staff, from the respiratory and microbiology departments.

Methods of sterilisation and disinfection

Sterilization is defined as the complete destruction of all micro-organisms, either by chemical or physical agents. Disinfection is defined as the destruction of potentially pathogenic micro-organisms. It is important to note that disinfection is possible without sterilization, but not vice-versa. Table 1 lists the methods that are generally available for sterilization and disinfection, their applications, their advantages and disadvantages, and which micro-organisms are likely to be killed by each method. Both sterilization and disinfection should be preceded by thorough cleaning.

Recommendations

a) General

All staff should be aware of the potential risks of transmission of infections to themselves, patients and other members of staff. It is the responsibility of all members of staff to take an active part in the infection control procedures within their own laboratory. When entering clinical areas staff should always wear appropriate protective clothing which should be changed and cleaned regularly. Laboratory clothing should not be worn in areas designated for recreation or for the consumption of food and drink. Similarly, food and drink should not be consumed in clinical laboratories.

b) Handwashing

Handwashing is probably the single most important procedure in the prevention of nosocomial infections. A variety of handwashing agents are available in most hospitals, ranging from soap and water to antiseptics. Soap and detergents suspend easily removable micro-organisms (and soil) allowing them to be washed off. Antiseptics control or kill micro-organisms contaminating the skin and other superficial tissues, and are sometimes composed of the same chemicals used for disinfection of inanimate objects. Although antiseptics and other handwashing agents do not sterilize the skin, they can reduce microbial contamination, depending on the amount and type of contamination, the agent used, the length of exposure to the agent, the presence of residual activity and the handwashing technique used. To encourage frequent handwashing, appropriate facilities should be made available in the area of the respiratory department. As liquid soap containers or bar soaps placed in pools of water can become contaminated by micro-organisms, containers should be regularly cleaned and bar soaps should be placed on racks to allow drainage of water (22).

Table 1

Methods of sterilization and disinfection

METHOD	PROCESS	COST	APPLICATIONS	ADVANTAGES	DISADVANTAGES	RANGE OF KILL
Low temperature steam (LTS)	Disinfection	Cheap	Small items ie. mouthpieces and tubing	Gives clean dry packaged items	1) Not "on site" 2) Needs stocks of items	Vegetative organisms, viruses - NOT hepatitis
Low temperature Steam + formaldehyde	Sterilization	Cheap	As for LTS	Kills spores etc not killed by LTS	As for LTS + Residual paraformaldehyde	Hepatitis + HTLVIII virus, spores, NOT C-J virus
High temperature steam	Sterilization	Cheap	All heat stable equipment	As for LTS	Damages heat labile equipment	All known pathogens
Hot water + low foam detergent (70°C)	Washing + disinfecting	Cheap	As for LTS	Installed within department	1) Initial high installation cost 2) May not give dry items	As for LTS
Chlorine releasing agents "Babysafe"	Disinfection	Cheap	Any item that can be immersed for 1 hr	1) Rapid process 2) In department	1) Items not dried 2) Rots aluminium and carbon steel	As for LTS: good viricidal agent
0.5% Chlorhexidine in industrial meths	Disinfection	Fairly expensive	As for chlorine releasing agents	As for chlorine releasing agents	1) May impart unsavoury tastes 2) Rots tubing etc	Most vegetative organisms
Activated 2% gluteraldehyde eg. "Cidex"	Disinfection or sterilization	Expensive	As for chlorine releasing agents		As for chlorhexidine	Vegetative organisms, TB, most viruses incl. Hepatitis + HTLVIII
Ethylene oxide	Sterilization	Very expensive	Extreme contamination	Dry wrapped items	) Limited access 2) Potential toxicity 3) Long turn around	All known pathogens

Indications: Personnel should wash their hands:

1. before performing test procedures.
2. after procedures during which microbial contamination of the hands is likely to occur, especially those involving contact either directly or indirectly with the mucous membranes.
3. following contact with inanimate objects or respiratory secretions likely to be contaminated with virulent or epidemiologically important micro-organisms.
4. after contact with an infected patient.
5. between contacts with different patients.

Technique: The recommended handwashing techniques depends on the purpose of the washing. For routine handwashing, a vigorous washing with soap under a stream of water for at least 10 seconds will remove most transient flora (23). Antiseptic handwashing should be used when staff need a reliable method of eliminating micro-organisms from their hands.

c) Handling of blood specimens

All blood samples, should be regarded as potentially dangerous, particularly so from patients suffering from suspected hepatitis, drug addiction etc. (inoculation risk patients). Therefore, the correct handling and processing of all blood sample should follow the same procedure.

When handling samples staff should wear appropriate protective clothing, and ideally wear latex or plastic gloves. Syringes containing blood should be handled with care, particularly if a needle is still attached. Needle-stick injuries can be reduced by discarding used needles immediately after use in puncture-resistant disposal containers. These containers should be provided (clearly labelled) in all sites where blood samples are to be taken. Needles should never be recapped, bent over or broken.

Spillages should be mopped up as soon as possible with an absorbent swab and the contaminated surface disinfected with a suitable disinfectant such as Chloros 1 in 10. Soiled swabs should be discarded in an appropriate bin. If a disinfectant is used which is known to become inactivated when mixed with organic material, it is important that the surface should subsequently cleaned thoroughly.

Gloves, if worn, should be removed carefully, to avoid contamination of the hands and discarded in appropriate bin or bag. The hands should be washed thoroughly.

d) Handling of medications and fluids

The handling of fluids and medications should as far as possible be carried out under aseptic conditions. Only sterile fluids should be used in nebulisers or humidifiers. Contaminated equipment should not be allowed to come into contact with fluids whilst they are being dispensed. Single dose or multidose medication vials, once opened should be stored according to the manufacturers' recommendations. No medication should be used after the expiry date on the label(19).

e) Respiratory function equipment

1. Nebuliser or humidifier fluid reservoirs should be filled immediately before use and any residual fluid remaining after therapy should be discarded. Re-usable nebulizers should be sterilized or disinfected and allowed to dry before being used on other patients (19).

2. All RFT equipment that comes into direct or close contact with mucous membranes such as mouthpieces and rebreathing valves, should be disinfected before use with other patients. Unfortunately, not all disinfection methods will inactivate all organisms of clinical significance, so the method selected should have a range of kill appropriate to the risk (24).

3. Breathing circuits including those containing exhalation valves should be cleaned and preferably sterilized (high level disinfection may be used) on a regular basis. No data is available indicating how often this should be done.

4. The internal workings of RFT equipment need not be sterilized or disinfected between patients. Where possible, the equipment should be dismantled and sterilized or disinfected regularly. Again, it is not known how often this should be done.

5. Where water sealed spirometers are used, the water should be regularly changed, the bell cleaned and dried and fresh distilled water used to refill the spirometer. No data is available indicating the most appropriate method of cleaning or how often the water should be changed.

6. Patients infected with a known pathogen should have respiratory function tests performed at the end of the day. Where this is not possible, aseptic techniques similar to those suggested by Depledge and Barrett (5) should be employed. High efficiency bacterial filters are an alternative, but these may affect the functional specifications of the device. The use of these filters has not been assessed.

7. Where items are designed for a single use (disposable), they should be discarded immediately after use.

f) Housekeeping and waste disposal

The role of microbial contamination of environmental surfaces in transmitting nosocomial infections is unclear, but probably of minor importance (18). Proper housekeeping will decrease the likelihood of large numbers of micro-organisms from such surfaces coming into contact with patients or staff. The need for clean work surfaces is obvious, but the methods of cleaning and the agents to be used have not been studied in relation to respiratory laboratories. With any cleaning procedure, clean areas should not subsequently become soiled. Cleaning devices such as mops and cleaning cloths should preferably be disposable.

Any hospital grade detergent can be used to clean surfaces. However, physical removal of micro-organisms by vigorous scrubbing, is probably of greater importance than the actual cleaning agent itself (24). Cleaning of surfaces should be done daily, except where continual soiling may occur, as around a blood gas analyser, where cleaning should be done immediately after contamination. Waste should be disposd of in the appropriate bags or containers which should be changed at least daily.

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DOES NEBULISED WATER CAUSE BRONCHOCONSTRICTION IN CLINICAL PRACTICE?

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Summary
Five mild asthmatics and ten patients with chronic severe asthma were challenged with water nebulised by a variety of methods. At no time was bronchoconstriction observed. This, together with experience of using water as a diluent in hospital and domiciliary practice, suggests that bronchospasm in response to nebulised hypotonic bronchodilator solutions is rare in clinical practice.

Introduction
Sterile water is commonly used as a diluent for bronchodilator solutions when using a nebuliser(1). In the Shrewsbury nebuliser clinic we have traditionally used cooled boiled water mixed immediately prior to use with the chosen dose of the drug to be nebulised. This is then given over 10 minutes using an electric compressor as the driving source. We use cooled boiled water as it is cheap, easily available and does not "fur up" the baffle on the nebuliser as does saline. There are approximately 300 patients of all ages using domiciliary nebuliser therapy and, in spite of using water as a diluent for up to five years, there have been no reports of acute bronchospasm during or after treatment. In hospital, for patients receiving nebulised bronchodilators, sterile water is used to make up the solution to 2 ml and again no diverse effects have been noted.

In view of reports of bronchial hyper-reactivity (2-5) with hypotonic solutions, it was felt that our current practice should be reassessed. A group of five mild asthmatics requiring occasional bronchodilators, and a more severely affected group of chronic stable asthmatics using regular home nebuliser therapy, were challenged with nebulised water.

Patients and methods
Study 1
Five patients aged 19-28 years, with known mild asthma and five patients with severe asthma (FEV_1 within 10% of predicted value) (6) were studied. All required to use beta-sympathomimetic aerosols occasionally, but none were administered within eight hours of the study. Their results were compared with those of five control subjects aged 20-27. On separate occasions, flow volume loops were measured before and 15, 30 and 60 minutes after inhalation of:-

1. 2 ml of water nebulised by an Inspiron electric compressor using an Inspiron Minineb nebuliser unit.
2. 1 ml of water via a Pulmosonic ultrasonic nebuliser.
3. 2 ml of saline (0.9%) delivered by the Inspiron compressor/nebuliser system.
4. 1 ml of saline (0.9%) via the Pulmosonic ultrasonic nebuliser.

All solutions were administered at room temperature (20-22°C) over a period of ten minutes, the nebuliser being tapped by hand to encourage a greater output.

Three flow volume loops were recorded on each occasion and the greatest used for the purpose of calculating results. 1 ml of water was used with the Pulmosonic nebuliser so that patients were challenged with a similar dose of water, as the Pulmosonic is a closed system and the Inspiron/Minineb an open one.

Study 2
Ten severe chronic asthmatics (FEV_1 less than 50% of predicted value with at least 15% reversibility), using regular nebuliser therapy at home, were challenged on separate occasions with:-

1. 2 ml of water nebulised by Inspiron compressor using an Inspiron Minineb nebuliser unit.
2. 2 ml of water nebulised by Inspiron compressor using a Bird nebuliser unit.
3. 2 ml of water via a Pulmosonic ultrasonic nebuliser.
4. 2 ml of water using a prototype spinning disc nebuliser.

As in Study 1, all solutions were given at room temperature (20-22°C) over ten minutes, the nebuliser being tapped by hand during administration.

Peak expiratory flow rate (PEFR), FEV_1 and vital capacity (VC) were measured before and 30 minutes after administration. The nebuliser units were weighed before and after administration in order to calculate the output. The Pulmosonic was allowed to stand for 30 minutes after the test and the residual solution was then drawn up using a needle and syringe. No bronchodilator was administered within four hours of the start of the study. All patients were receiving other therapy at the time of the study; ten were receiving inhaled steroids, six oral aminophylline and two oral steroids.

Table 1

Study 1: **Effects of water inhalation on lung function* in 5 controls and 5 asthmatics**

		PEFR l/min	FEV_1 litres	VC litres
Jet nebuliser				
Asthma		443 (58)	3.41 (0.55)	4.66 (0.72)
% change after:	15 min	−2	−1	−12
	60 min	+2	−10	−13
Controls		473 (44)	4.04 (0.77)	4.98 (1.16)
% change after	15 min	10	−1	−1
	60 min	−4	+3	0
Ultrasonic nebuliser				
Asthma		451 (75)	3.37 (0.63)	4.19 (0.91)
% change after	15 min	−1	+2	−2
	60 min	+1	+7	−2
Controls		486 (65)	4.13 (1.43)	4.87 (1.35)
% change after	15 min	−2	+4	0
	60 min	+5	+4	+1

* Mean values with standard deviation in brackets and percentage change.

The values obtained before and after the administration of water and saline were compared using the paired "t" test.

Results

Study 1: Mild Asthma

Although matched for age, sex and height, mean values for lung function for the mild asthmatics were consistently lower than the controls, but there was no significant change in any of the values after inhalation of water nebulised by either method. Table 1 shows the results and percentage change after giving 2 ml jet and 1 ml ultrasonically nebulised water. It can be seen that after 2 ml of water from the jet nebuliser the maximum fall (at one hour) in FEV_1 was 10% in the asthmatics and 3% in the controls. After ultrasonically nebulised water, there was a slight improvement in both asthmatics and controls.

Table 2 shows the results and percentage change after exposure to 2 ml of jet nebulised and 1 ml of ultrasonically nebulised saline. There is an improvement in FEV_1 after 2 ml of jet nebulised saline in both the asthmatics and controls. After ultrasonically controlled nebulised saline, there is a slight fall in FEV_1 in both the asthmatics and controls, slightly greater in the asthmatics. These changes were not significant.

The values for V max 75, V max 50 and V max 25 were also calculated from the flow volume loops, but these showed no significant changes after saline or water, and the values are not included in the tables.

Study 2: Severe asthma

In the group of ten severe asthmatics given 2 ml of water on four separate occasions with different nebuliser/compressor systems, patients showed a slight improvement in PEFR, FEV_1 and VC 30 minutes after administration (Table 3). These changes were not significant.

The mean output measured on each occasion was 1.65 ml (SD: 0.13) with the Minineb, 1.55 ml (SD: 0.2) with the Bird, 0.81 ml (SD: 0.19) with the spinning disc, and 1.48 ml (SD: 0.15) with the ultrasonic nebuliser.

Table 2

Study 1: **Effects of saline inhalation on lung function* in 5 controls and 5 asthmatics**

		PEFR 1/min	FEV_1 litres	VC litres
Jet nebuliser				
Asthma		427 (87)	3.31 (0.89)	3.93 (1.08)
% change after:	15 min	−3	+2	−4
	60 min	+2	+3	+2
Controls		476 (71)	3.99 (1.2)	4.75 (1.38)
% change after	15 min	+4	+10	+2
	60 min	+7	+6	+2
Ultrasonic nebuliser				
Asthma		486 (48)	3.74 (0.73)	4.30 (0.78)
% change after	15 min	−1	−4	−2
	60 min	+2	−10	−7
Controls		503 (66)	4.14 (1.01)	4.7 (1.14)
% change after	15 min	+2	−4	0
	60 min	+5	+4	+1

* Mean values with standard deviation in brackets and percentage change.

Table 3

Study 2: **mean values and % change in lung function indices following administration to ten severe asthmatics of water nebulised by a variety of methods**

		PEFR 1/min		FEV_1 litres		VC litres	
	Time (min)	Mean	SD	Mean	SD	Mean	SD
Minineb	0	220.5	61.9	1.35	0.72	2.49	1.13
	30	251.0		1.42		2.64	
	% change	13.8		5.20		6.00	
Pulmosonic	0	263.5	130.1	1.42	0.63	2.59	1.03
	30	274.0		1.51	2.72		
	% change	4		6.30		5.00	
Spinning disc	0	249.0	83.9	1.49	0.65	2.62	1.04
	30	268.0		1.55		2.70	
	% change	7.6		4.00		3.00	
Bird	0	218.5	82.1	1.32	0.65	2.52	1.20
	30	227.5		1.32		2.53	
	% change	4.1		0		0.40	

Discussion

In the present study, normal subjects and mild asthmatics showed only small insignificant changes in lung function following the inhalation of nebulised water or saline. In no case did we observe a fall of 20% or greater in any parameter measured. In severe asthmatics, the reverse was found, and the patients showed a small but insignificant improvement in lung function in response to inhaled water. This differs from the findings in studies of the use of nebulised water as a method of bronchial provocation (2-5). These differences are difficult to explain. However, we would accept that we measured lung function at 15-30 minutes after inhalation, whereas in the above studies lung function tests were performed within two minutes of the completion of inhalation. The present study may, therefore have failed to identify these changes. However, none of our patients complained of breathlessness during or immediately following administration.

The absence of significant bronchoconstriction in the present study is in contrast to the other studies (2-5). It is difficult to believe that it is due to any unusual characteristic of the asthmatic patients being studied. The differences between our results and others could be due to the small numbers involved, or due to the fact that the dosage of water delivered to the patients was less. However, one study (5) demonstrated that twenty eight asthmatics showed 20% decrease in FEV_1 with less than 2 ml of water delivered from the nebuliser. The nebuliser used was a Mistogen electronic nebuliser, which gives a constant ultrasonic mist with a particle size of 2-10 microns. The nebulisers used in the present study gave a mist which diminished in quantity with time, and may have delivered a smaller number of particles in this size range to the patient.

We would have to accept that we have no satisfactory explanation for the fact that our results differ from those in other studies. However, our findings together with experience of using water as a diluent regularly, both in hospital and domiciliary practice, lead us to suspect that the incidence of bronchospasm in response to nebulised hypotonic bronchodilator solutions is unusual in clinical practice.

Saline has been recommended as a diluent for "Atrovent" respirator solution, which has been shown to cause bronchoconstriction when inhaled as a hypotonic solution. With beta adrenergic bronchodilator solutions, however, we see no reason why distilled water or, as in our practice, cooled boiled water from the kettle should not continue to be used as a diluent. This also avoids the problem of blocking the jet with salt crystals when using saline, which can dilute the respirator solution.

Acknowledgment

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BOOK REVIEWS

RESPIRATORY PHYSIOLOGY — the Essentials

J B West 3rd edition

Williams and Wilkins, 1985. 183 pages

ISBN 0-683-08940-4. Price £14.00 (soft cover)

This book, based originally on a series of lectures to medical students, has, since it was first published (1974), provided one of the most useful and essential texts for anyone who wishes to obtain a clear, concise account of respiratory physiology. The text is one of the most readable, clear and uncomplicated texts available on the subject. In combination with its two companion volumes — Ventilation/Blood Flow and Gas Exchange, and Pulmonary Pathophysiology — the essentials, they provide a short, but comprehensive guide to Respiratory Physiology and the effects of disease.

This 3rd edition has been brought up to date in several areas, principally those of lung metabolism, surfactant and the control of ventilation. For those who have not previously read this volume, it deals firstly with the structure and function of the lungs, and then covers the processes of ventilation, diffusion, blood flow, gas transport, lung mechanics, and control of ventilation. The final two chapters cover respiration in unusual environments and tests of pulmonary function. The book continues with the author's bias towards emphasizing the chief role of the lung as a gas exchange unit, rather than covering in vast detail such areas as control of ventilation, which although important, is often over-emphasized in other texts. The balance in the 3rd edition remains good.

The test is liberally illustrated, with mathematical equations kept to the minimum. The appendix on symbols and equations is a short, but useful section.

I continue to believe that this is one of the best short texts on respiratory physiology, and that it is particularly useful for student technicians wishing to understand the essential physiological principles of respiratory physiology.

I have one criticism to level at this book. I think that the almost 100% increase in the price of this book compared to the 2nd edition is wholly unjustified, particularly for such a useful and popular text!!!

Adrian Kendrick

LECTURE NOTES ON RESPIRATORY DISEASE

R A L Brewis 3rd edition

Blackwell Scientific Publications, 1985, 390 pages.

ISBN 0-632-01412-1. Price £8.50 (soft cover)

The original aim of this book was to present a concise review of respiratory disease. The book is primarily aimed at medical students and general medical readers, but this should not discourage technicians and respiratory physiologists from reading and referring to it. Unlike many other subsequent editions of other texts, this book remains at an extremely reasonable price.

For the 3rd edition the text has been completely reviewed and updated and a number of new figures have been added. Two new chapters — on Defences of the lung and on Cystic Fibrosis are included, and many of the other chapters have been expanded, in particular the chapter on Pulmonary Function tests and blood gases. The result is a slightly thicker volume, which still fits in a labcoat pocket!

As with previous editions, the emphasis is on clinical aspects of the commoner disorders. Each chapter, where appropriate, gives details on the prevalence, aetiology, clinical features, pathological features and management of the disorder. Each disorder is covered in a clear, uncomplicated manner, with unnecessary over-detail avoided. The section on "further information" provides a short, but useful selection of the more important reference works, each work being accompanied by a critical comment from the author.

Overall, this edition continues in the same vein as the previous editions, in providing a clear, concise and useful account of the principle respiratory disorders. It provides a useful reference book not only for doctors, but also for technicians who wish to broaden their knowledge of particular diseases, without being floored by the degree of detail. Finally, not only does Dr Brewis write a good book, he also continues to excel in the illustration department.

Adrian Kendrick

CORRESPONDENCE

I was interested to read the paper by Kendrick et al. in the latest issue of Breath (Nov 1985 : Issue 26), particularly since their thinking with regard to the design of databases seems to have run very much in parallel with our own.

Our database is also written in BASIC, in our case the well structured BASIC09. This BASIC is ideal for databases since it allows entire records with fields for text, integers, real numbers or single bytes to be defined as single data structures. It runs under OS9, a multi-user, multitasking operating system which allows even BASIC programs to use numbers of sub-programs or procedures, which are held in common by the main programs. This modularity enables us to hold our commonly used programs in memory and select them by user-defined function keys. It also allows easy modification of programs. The most commonly used programs cover the calculation of results from raw data, various methods for recovering old data, and changing data (e.g. addresses).

Our database stores patient's name and number, date of birth, address, sex, race and consultant. Test results are linked to this personal data and include smoking history, spirometry (including two sets of drug responses), transfer factory, helium and box lung volumes, and six other test groups containing about 40 numbers. Diagnosis and operator's comments may be stored as text and as numerical codes. Normal values are calculated from height, race, date of birth and the test date. I enclose a typical report and a dump of the records from which it was derived.

We would be willing to give our programs in their present form to any other NHS user with an OS9 system. For reasonable speed of use the system should have at least 128k of RAM and disc access using DMA. One quad density, double sided floppy will hold data on over 1,200 patients, while a 10 Mbyte hard disc will hold about 18,000 patients with an average of about 1.5 tests each.

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Southampton.

Typical Report

SOUTHAMPTON GENERAL HOSPITAL
LUNG FUNCTION

Name: Heath, John Roger No. 123456 27 Nov 1985
Address 1 South Rd,
Southampton,
SO1 2XX

D.O.B. 21 1 44 Male Consultant GMS

Time 16 hrs Origin OP

Diagnosis
Forty characters for diagnosis

Smoking history
Smoker
140 grammes/wk large cigars
Ex 10 years 0 months
210 grammes/wk manufactured cigarettes

Age 41 Height 1.690 Weight 79.4 Male

SPIROMETRY

	FEV	FVC	FEV%	V50	PEF
Predicted	3.59	4.32	83.1	4.79	527
Post-becotide	2.91	3.42	85.1	1.20	564

TRANSFER FACTER

	VI	RV	TLC	KCO	TLCO
Predicted	4.51	1.88	6.43		10.05
Mean of 2	2.73	2.55	5.28	1.43	7.39

OPERATOR'S COMMENTS
Spirometry unreliable: leaks
TLCO unreliable: small VI
Here are 64 characters of operator's comments

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FAMT NEWS

Educational Affairs

Dorothy Battye
Education Spokesman

No doubt members will recall a document put forward by the FAMT in 1983 entitled: The Case for a Higher Award for Medical Physics and Physiological Measurement Technicians. At a preliminary meeting in 1984 with Mr. Clifford Gregory, then Chief Scientific Officer at the DHSS, it was decided to circulate this document to all relevant medical and scientific bodies concerned with MPPM technicians and to the Regional Scientific Officers (RSOs). This was done and the following is a summary of the replies:

Survey on Higher Awards

	Number of submissions	Replies
Regional Scientific Officers	14	3
Organisations and Institutions	19	12
Individual Circulation	11	5
	44	20
Unsolicited Replies		4

Results

Totally in favour	17
In favour with reservations	3
Against	4
No replies	24

The results of the survey were sent, earlier this year, to all those individuals and Societies who had originally been circulated, whether they had replied or not, after which five more replies were received from the RSO's.

At this stage, the FAMT sought a meeting with Dr. Woodford, Mr Gregory's successor, which was held in May, 1985, when representatives of all the member associations of the FAMT were present. No conclusions were reached at this meeting, but Dr. Woodford extended an invitation to two representatives from the central council to meet the RSO's at a meeting in July. Mrs Sally Gough and I attended.

There was general agreement at this meeting that further qualifications were necessary for some technicians, but not all. It was stated by the RSO's that to make such qualifications mandatory would constitute an intolerably inflexible situation for staff and management and would prevent those less qualified but experienced from achieving further promotion. The consensus was that technicians should be appropriately trained for their jobs (the operative word being "appropriately") but that making a qualification mandatory was not necessarily the best way of achieving this.

Mrs. Gough and I asked that the RSO's should take this matter up with Regional Scientific Committees as we were aware that this procedure had not been followed in all Regions. It was pointed out by us that the result of the questionnaire sent out earlier this year to all relevant medical and scientific bodies had been overwhelmingly in support of the FAMT's proposals and it seemed to us, therefore, that consultation within the Regions should be pursued. Dr. Woodford asked the RSO's to do this.

We pointed out that the paper published by the RSO's entitled 'Scientific Integration of Staffing Structures', recommended that the route to the top of the technician ladder should be by higher qualification, namely H/TEC; however, no further discussion took place on this issue at the meeting.

At this stage, therefore, we still have a body of opinion against mandatory higher qualifications. However, as I have said on previous occasions when it appeared we had an impasse, a satisfactory outcome will eventually be found. If anyone expected the question to be resolved at this comparatively early stage of negotiation, that person must be living in a fantasy world. It took ten years to resolve the problems of basic qualifications and they are not totally resolved yet. We have only been negotiating for higher qualifications for two years, so we have some way to go.

The meeting was in no way acrimonious and the FAMT wishes to keep its good relationship with the DHSS as it has done for the past ten years. The central council of the FAMT will continue to look at this question and member groups can be assured that the matter of higher qualifications is not closed.

CENTRAL REGISTER OF COMPUTER PROGRAMMES IN RESPIRATORY MEDICINE

Would all members please note the existence of the above register? This register was set up to provide a central contact point for those who wish to use and develop computer programmes in the respiratory field. It provides details of programmes which have been developed, each programme's applications and hardware required for each. A small fee (i.e. "media costs") would be payable by the borrower to the centre providing the programmes.

In view of the programmes and correspondence (see this edition) recently published in *Breath*, could all members who have useful programmes that they are prepared to share with other departments please register these? Registration is free! At a later date *Breath* may publish the full listing.

Details and registration forms are available from:—

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

BADGES AND BINDERS

ARTP badges in blue enamel with the ARTP logo in gold will be available shortly at a cost of £1.25 each. They will be obtainable from:

Mrs. Sonia Jackson,
Pulmonary Physiology Unit,
Frenchay Hospital,
Frenchay, Bristol.

Binders for *Breath* are available at a cost of £5.00 each. Each binder will hold 12 editions of *Breath*. They may be obtained from:

Mr. Adrian Kendrick,
Respiratory Department,
Bristol Royal Infirmary,
Bristol, BS2 8HW.

SELECTED ARTICLES 1985

BULLETIN EUROPEEN de PHYSIOPATHOLOGIE RESPIRATOIRE

Volume 21

Ghaem A, Martineaud J P.
Determination of nasal resistance by two rhinomanometry techniques in normal man. p 11-17.

Mehia R J W, Swan A V, et al.
Suitability of a new turbine spirometer for epidemiological surveys in children. p 43-8.

Cotes J E.
Editorial — Standardization of lung transfer factor. p 123-4.

Morris A H, Crapo R O.
Standardization of computation of single-breath transfer factor. p 183-90.

Teculescu D B.
Transfer factor of the lung: time is come for a standardization. p 215-17.

Stradling J R, Chadwick G A, et al.
Respiratory inductance plethysmography: calibration techniques, their validation and the effects of posture. p 317-24.

Minette P, Dubois P, et al.
Validity of air-helium DVmax measurements in trials of bronchodilators. p 357-62.

Lockhart A, Regnard J.
State of the art: Exercise and hyperventilation induced asthma (French). p 399-409.

Colebatch H J H, Greaves I A, et al.
Pulmonary distensibility and ventilatory function in smokers. p 439-48.

Rodenstein D O, Sopwith T, et al.
Re-evaluation of the radiographic method for measurement of total lung capacity. p 521-25.

Hedenstrom H, Malmberg P, et al.
Reference values for lung function tests in females. Regression equations with smoking variables. p 551-58.

CHEST

Volume 87

Hopewell P C, Luce J M.
Pulmonary involvement in the Acquired Immunodeficiency Syndrome. p 104-12.

Krieger J, Weitzenblum E, et al.
Flow volume curve abnormalities and obstructive sleep apnea syndrome. p 163-67.

Monell F, Orriols R, et al.
Usefulness of skin tests in Farmers' Lung. p 202-5.

Cotton D J, Graham B L, et al.
Reduction of the single-breath CO diffusing capacity in Cystic Fibrosis. p 217-22.

Slepian I K, Matthews K, et al.
Aspirin sensitive Asthma. p 386-91.

Findley L J, Wilhoit S C, et al.
Apnea duration and hypoxemia during REM sleep in patients with obstructive sleep apnea. p 432-6.

Onal E, Leech J A, et al.
Relationship between pulmonary function and sleep induced respiratory abnormalities. p 437-41.

Glassforth J.
The pulmonary complications of AIDS; evaluating the tests. p 562-3.

Volume 88

Jones O B, Wilhoit S C, et al.
Oxyhaemoglobin saturation during sleep in subjects with and without the obesity hypoventilation syndrome. p 9-15.

Harber P, Soohoo K, et al.
Is the MVV:FEV1 ratio useful for assessing spirometry validity? p 52-7.

Becklake M.
Chronic airflow limitation:- its relationship to work in dusty occupations. p 608-17.

Berry R B, Fairshter R D.
Partial and maximal flow-volume curves in normal and asthmatic subjects before and after inhalation of Metaproterol. p 697-702.

JOURNAL OF APPLIED PHYSIOLOGY

Volume 58

Begin P, Peslin R, et al.
Evaluation of phase correction and low gas density to improve thoracic gas volume measurements. p 346-51.

Graham B L, Mink J T, et al.
Effect of breath-hold time on DLco (SB) in patients with airway obstruction. p 1372-77.

Inman M D, Hughson R L, et al.
Comparison of cardiac output during exercise by single-breath and CO_2 rebreathing methods. p 1372-77.

Kallay M C, Hyde R W, et al.
Effect of rebreathing pattern on pulmonary tissue volume and capillary blood flow. p 1881-94.

Prior J G, Powlson M, et al.
Ventilatory changes during exercise and arterial PCO_2 oscillations in chronic airway obstruction. p 1942-48.

Volume 59

White D P, Weil J V, et al.
Metabolic rate and breathing during sleep. p 384-91.

Brunner J X, Wolff G, et al.
Accurate measurement of N_2 volumes during N_2 washout requires dynamic adjustment of delay time. p 1008-13.

Perez W, Tobin M J.
Separation of factors responsible for changes in breathing patterns induced by instrumentation. p 1515-20.

CLINICAL SCIENCE

Volume 68

Green M, Moxham J.
The respiratory muscles. p 1-10.

Wedzicha J A, Cotter F E, et al.
Gas transfer for carbon monoxide in polycythaemia secondary to hypoxic lung disease. p 57-62.

Winning A J, Hamilton R D, et al.
The effect of airway anaesthesia on the control of breathing and the sensation of breathlessness in man. p 215-25.

Cockroft A, Beaumont A, et al.
Arteial oxygen desaturation during treadmill and bicycle exercise in patients with chronic obstructive disease. p 327-32.

Bush A, Miller J, et al.
Some observations on the role of the abdomen in breathing in patients on peritoneal dialysis. p 395-9.

Volume 69

Makridges L, Heienhauser G J F, et al.
Maximal short term exercise capacity in healthy subjects aged 15-70 years. p 197-205.

Tan E T H, Lambie D G, et al.
Sleep apnoea in alcoholic patients after alcohol withdrawal. p 655-61.

Adams L, Lane R, et al.
Breathlessness during different forms of ventilatory stimulation: a study in normal subjects and respiratory patients. p 663-72.

CLINICAL PHYSICS AND PHYSIOLOGICAL MEASUREMENT

Volume 6

Gaskell S J.
Mass spectrometry in medical research. p 1-16.

Graham B L, Buchanan P R, et al.
Data acquisition from a multiplex, quadrupole mass spectrometer. p 17-26.

Schoknecht G, McManus C.
The influence of measurement precision on medical findings. p 161-70.

Fellows I W, MacDonald I A.
An automated method for the measurement of oxygen consumption and carbon dioxide excretion in man. p 349-55.

GUIDELINES FOR CONTRIBUTORS TO BREATH

Breath is the Journal of the Association of Respiratory Technicians and Physiologists (ARTP) and is published three times a year. Both members of the Association and non-members are invited to submit original articles, reviews, or case reports in the field of respiratory medicine, physiology or technology; articles relating to other disciplines are also welcome. Two copies should be submitted to the Editor, Dr. D C S Hutchison, Department of Thoracic Medicine, King's College School of Medicine, Denmark Hill, London SE5 8RX. Articles are accepted on the understanding that they may undergo editorial revision.

The Editor would be grateful if contributors would observe the following guidelines:

Material should be typed in double spacing on one side of the paper only and authors should keep one copy. Original articles should follow the usual format of (in order), a summary of 200 to 250 words, introduction, methods, results and discussion. Each table should be typed on a separate sheet and numbered in order of appearance. Figures should be submitted as original art-work in black on a white background or as half-plate glossy prints, all marked on the reverse with the name of the first author and the figure numbers in order of appearance. Legends to figures should be typed on a separate sheet.

Units and Symbols: This journal uses SI units only (blood pressure should be given in mm Hg). Abbreviations and symbols should be defined at first appearance. Acceptable symbols, units and abbreviations for lung function indices are given in Bull Europ Physiopath Respir, Suppl 5, 19, 52-61, 1983.

References: References should be numbered in the text in brackets in the order in which they first appear eg. (12). The reference list should be typed in the same order on separate sheets. References should be typed as in the following examples (Abbreviations as given in Index Medicus):

Original Article:

1. Ogilvie C M, Forster R E, Blakemore W S, Morton J W (1957). A standardized breathholding technique for the clinical measurement of the diffusing capacity of the lung for carbon monoxide. J Clin Invest 36 1-17.

Book:

2. Crofton J, Douglas A (1981). Respiratory diseases: 3rd Edn. Chap 15, 265-77. Blackwell Scientific Publications. Oxford.

Section in Edited Book

3. Morgan P K (1983). Physical Gas Analysers. In: Measurement in Clinical Respiratory Physiology. Eds. Laszlo G, Sudlow M F. Academic Press, 113-30.

Proofs will be sent to the first author unless otherwise requested. They should be corrected and returned as soon as possible. Only minor corrections can be undertaken at the proof stage.

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Advertisements: Applications for space and enquiries should be addressed to: Sue Hill, Pulmonary Function, The General Hospital, Steelhouse Lane, Birmingham B4 6NH. Telephone: 021 236 8511.

NOTE FROM THE EDITORS

Vacancies advertised in *Breath*

We are glad to accept advertisements for job vacancies in *Breath* but regret that we are unable to take responsibility for verifying that the conditions of the post are as advertised. We strongly advise applicants for any post to check on the terms and conditions of service and particularly on special items such as equipment or training facilities. We would be glad to hear of any such errors that arises in job advertisements appearing in *Breath*.

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Closing date for receipt of applications: 30th April, 1986.

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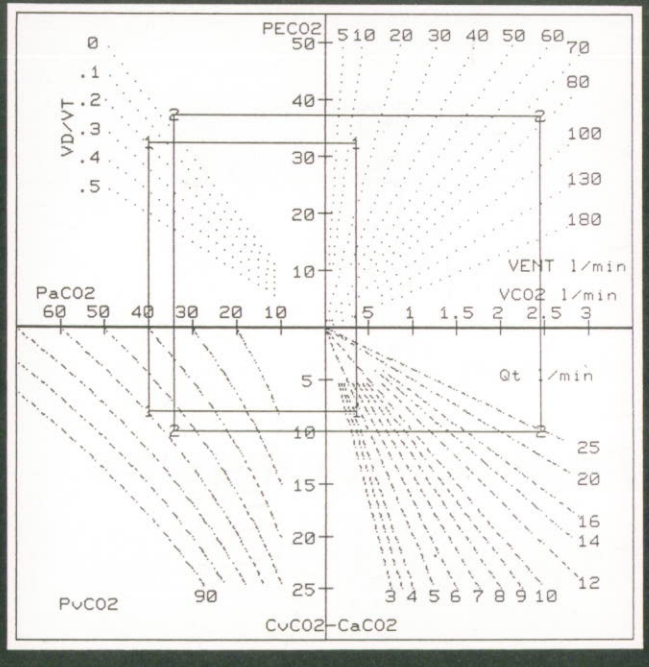

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