ASSOCIATION OF RESPIRATORY TECHNICIANS AND PHYSIOLOGISTS

ISSUE NO. 26 NOVEMBER 1985

BREATH

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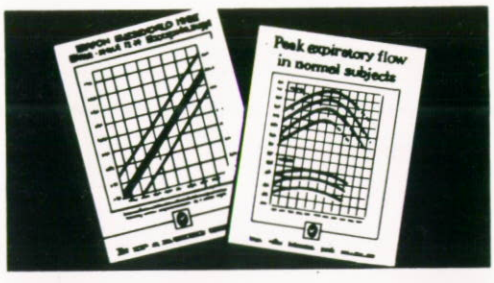

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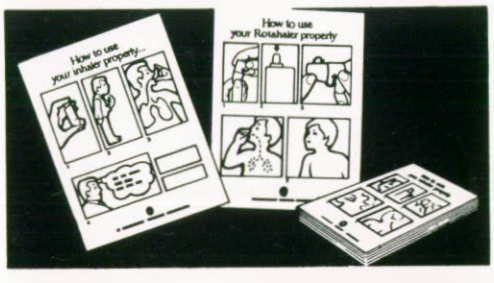

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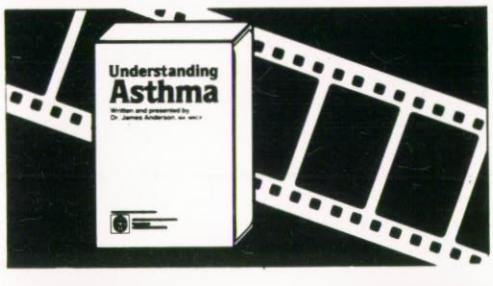

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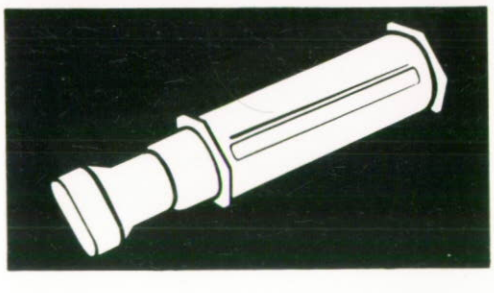

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DIAPHRAGMATIC PARALYSIS

John G. Williams
Regional Cardiothoracic Unit, Broadgreen Hospital, Liverpool.*

*Present address: Halton Hospital, Runcorn.

There has been a considerable resurgence of interest in respiratory muscles and their function in recent years. Diaphragmatic paralysis forms part of the spectrum of respiratory muscle disease and may cause troublesome symptoms interfering with the patient's way of life and necessitating surgical intervention.

Anatomy and physiology

The diaphragm is a dome shaped structure with a central fibrous tendon. Muscle fibres are arranged around the tendon and are attached to the lower costal margin, sternum and vertebrae. The diaphragm is innervated by the left and right phrenic nerves. On contraction of the diaphragm the central tendon descends and this together with contraction of the intercostal muscles causes expansion of the thoracic cavity. This results in the lowering of the pleural pressure relative to that of the atmosphere so that air enters the lungs. The diaphragm is the main muscle contracting during quiet inspiration, and its movement is responsible for about 75% of the volume of gas inhaled.

Causes of diaphragmatic paralysis

Paralysis of one side of the diaphragm is invariably due to phrenic nerve damage. This is commonly due to compression from cervical spine osteoarthrosis or to trauma and quite often follows knife wounds in the posterior triangle of the neck or surgery within the thorax. The phrenic nerve may be affected as part of a disease process affecting all nerves such as herpes zoster or poliomyelitis. Bilateral diaphragmatic paralysis is usually due to motoneurone disease or to a primary muscle disorder such as acid maltase deficiency or muscle dystrophy.

Symptoms

Unilateral diaphragmatic paralysis seldom causes symptoms, unless there is underlying lung disease. Bilateral paralysis on the other hand is usually symptomatic, the main complaint being of dyspnoea on lying flat due to the unopposed movement of abdominal contents into the thorax, compressing the lung. Dyspnoea on effort may occur and some patients complain of flatulence which is thought to be due to impairment of oesophageal sphincter function.

Diagnosis

Radiology: The diagnosis of diaphragmatic paralysis may be confirmed by screening the diaphragm radiologically. *Unilateral* diaphragmatic paralysis may be detected by observing the upward (paradoxical) movement of the diaphragm during inspiratory movements such as sniffing, in contrast to the normal downward movement of the unaffected side. (Plain radiograph — fig. 1).

Radiological screening for diaphragmatic paralysis is best performed in the supine position. If screening is performed in the upright position the flaccid diaphragm may be pushed upwards during expiration by the movement of abdominal contents as a result of abdominal muscle contraction. At the onset of inspiration abdominal muscles relax, the abdominal contents move downwards under the force of gravity and the diaphragm also moves downwards.

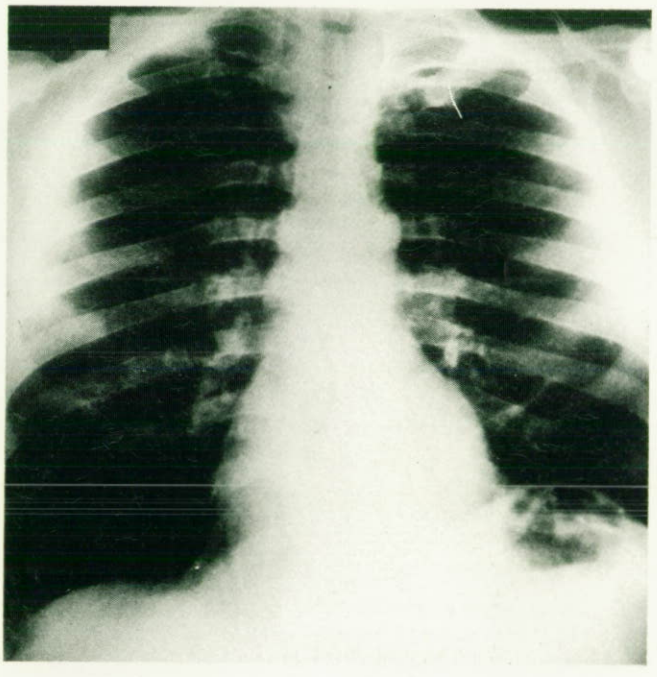

Fig. 1: *Chest radiograph showing L-sided unilateral diaphragmatic paralysis.*

This downward motion of the diaphragm may be interpreted as normal movement. In the supine position however, the abdominal contents will be seen to move into the thorax on inspiration, unopposed by the flaccid diaphragm.

Transdiaphragmatic pressure: Measurement of trans-diaphragmatic pressure (Pdi) provides another means of diagnosis (1). Pdi is the intragastric pressure minus the oesophageal pressure. These pressures are measured by balloon catheters placed in the oesophagus and stomach which give estimates of intrapleural pressure and intra-abdominal pressure respectively. At resting end-expiration Pdi is approximately zero, the oesophageal pressure being 3 to 5 cm H_2O greater than atmospheric. During quiet inspiration, Pdi increases to between 5 and 8 cm H_2O as oesophageal pressure becomes 3 to 4 cm H_2O more

positive; during maximal inspiration Pdi usually exceeds 25 cm H_2O, though there is considerable variation between individuals. In bilateral diaphragmatic paralysis no change in Pdi occurs even during maximal inspiration. (Fig. 2).

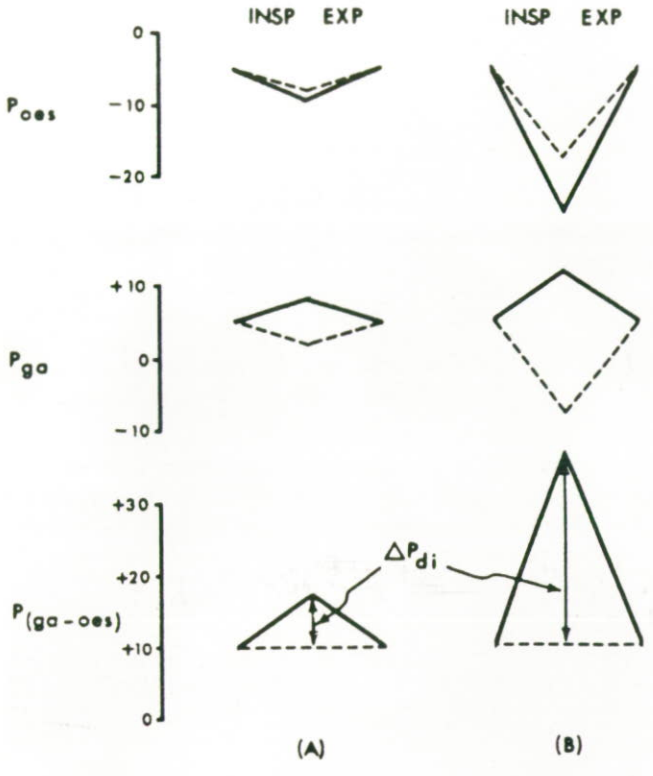

Fig. 2: Diagram of pressure changes (cm H_2O) during quiet breathing (A) and during maximal inspiration (B). Poes: oesophageal pressure. Pga: gastric pressure. P(ga-oes) : transdiaphragmatic pressure. ΔPdi : change in transdiaphragmatic pressure. Continuous lines : normal diaphragm. Broken lines : bilateral diaphragm paralysis. (Reproduced by kind permission of the authors and the Editor of 'Medicine')

Pulmonary function tests

Patients with diaphragmatic paralysis show abnormalities in pulmonary function tests, those with bilateral paralysis being more severely affected than those with unilateral paralysis.

(i) Lung volumes: All lung volumes are reduced and patients exhibit a restrictive pattern of abnormality. Table 1 shows the mean lung volume measurements of 17 patients from our unit who had unilateral diaphragmatic paralysis. There is a further significant reduction in lung volumes, apart from residual volume, on assuming the supine posture. The vital capacity may be reduced by as much as 50% on lying down in patients with bilateral diaphragmatic paralysis, whereas the expected normal fall in vital capacity is only 3%. Patients with right sided diaphragmatic paralysis have a greater fall in vital capacity than those with left sided paralysis (19% versus 10%), probably due to the effect of the liver mass. The expiratory reserve volume may decrease by at least 50% in cases of unilateral paralysis.

(ii) Gas exchange: Blood gas abnormalities have been described in diaphragmatic paralysis. Patients may be hypoxic on lying flat. The PaO_2 is increased on sitting up and increased further on exercise. Many studies have been performed to establish the cause of the abnormality in gas exchange (2-4).

Although patients may have a reduced transfer factor, the transfer coefficient is usually greater than normal. These results reflect the reduction in lung volume rather than a true diffusion defect (2).

Regional lung function studies have demonstrated abnormal ventilation-perfusion relationships at the lung base overlying the paralysed diaphragm (3, 4). There is an equal reduction in both ventilation and perfusion, approximately 20%, in the sitting position. A greater reduction in ventilation than perfusion occurs once the supine posture is assumed. Closing volume measurements, expressed as a percentage of vital capacity, tend to be less than predicted and indicate early airways closure (2).

(iii) Pulmonary mechanics: Gibson et al have studied the pulmonary mechanics of seven patients with paralysis or gross weakness of the diaphragm (5). There was some reduction in the mean peak expiratory flow rate, but flow rates were normal once the absolute lung volume had been taken into account. Maximal and minimal pleural pressures were measured at differing lung volumes. The minimal pleural pressure measurement showed little variation with lung volume indicating reduction of inspiratory muscle strength. The static expiratory pressure volume curves showed decreases in both maximal transpulmonary pressure and static expiratory compliance. Dynamic compliance during tidal breathing was only slightly less than static expiratory compliance. These results cannot be explained by the reduction in lung volume alone, and it has been postulated that the low compliance results either from micro-atelectasis or from a generalised alteration in alveolar elastic properties. (The low compliance may explain why patients with diaphragmatic paralysis breathe at a rapid rate with a small tidal volume).

(iv) Exercise testing: Diaphragmatic paralysis reduces the capacity for exercise. We studied the ventilatory and cardiac responses of eight patients with unilateral diaphragmatic paralysis (6), who were all free from lung disease. Minute ventilation at oxygen uptake of 1.0 and 1.5 l/min was significantly greater than that of the control group. The mean maximal oxygen uptake was only 54% of predicted, the mean maximal cardiac frequency was

TABLE 1

Mean sitting lung volumes in 17 patients with unilateral diaphragmatic paralysis.

	% of predicted	
	Mean	Standard Error
Total lung capacity	69	2.5
Vital capacity	65	3.9
Functional residual capacity	91	4.2
Residual volume	84	3.6
Forced vital capacity	68	3.6
Forced expiratory volume (1.0 sec).	73	4.1

75% of predicted and mean maximal exercise ventilation 63% of predicted. These results indicate that respiratory muscle weakness was the limiting factor to further exercise. The alveolar-arterial oxygen difference was high at rest and decreased significantly during exercise. This change was associated with an improvement in the arterial oxygen tension. This pattern of improved gas exchange during exercise is due to the improved ventilation of the atelectatic areas overlying the paralysed diaphragm.

Prognosis

It is unusual for the diaphragm to recover once it is paralysed (7), the notable exception being the paralysis that may occur following open heart surgery (8). This has been attributed to cold injury to the phrenic nerve during cardiopulmonary bypass. 75% of these patients show improvement in diaphragmatic function within six months.

Treatment

Unilateral paralysis seldom requires treatment but if possible, it is wise to wait for at least 14 months to allow the phrenic nerve to regenerate from any insult before contemplating active therapy. A variety of surgical treatments have been advocated for patients with severe symptoms, diaphragmatic patch, or vago-phrenic anastomosis for example. Recently diaphragmatic plication has been evaluated in patients with severe symptoms due to unilateral paralysis (9). In this operation the diaphragm is made taut by invagination of successive layers of diaphragmatic muscle. Objective, as well as subjective improvement in pulmonary function has been documented. The improvement has been maintained during a follow up period ranging from 10 months to 5 years.

Diaphragmatic pacing: Provided that both nerve and muscle are normal, a paralysed diaphragm can be made to contract by electrical stimulation of the phrenic nerve. This treatment has been used in quadriplegic patients (10). An electrode is placed in contact with the nerve, in the neck or within the thorax, and impulses are discharged at a rate of 10 to 12 per minute to simulate respiration. In adults the diaphragms are paced alternately for 6 to 12 hours at a time.

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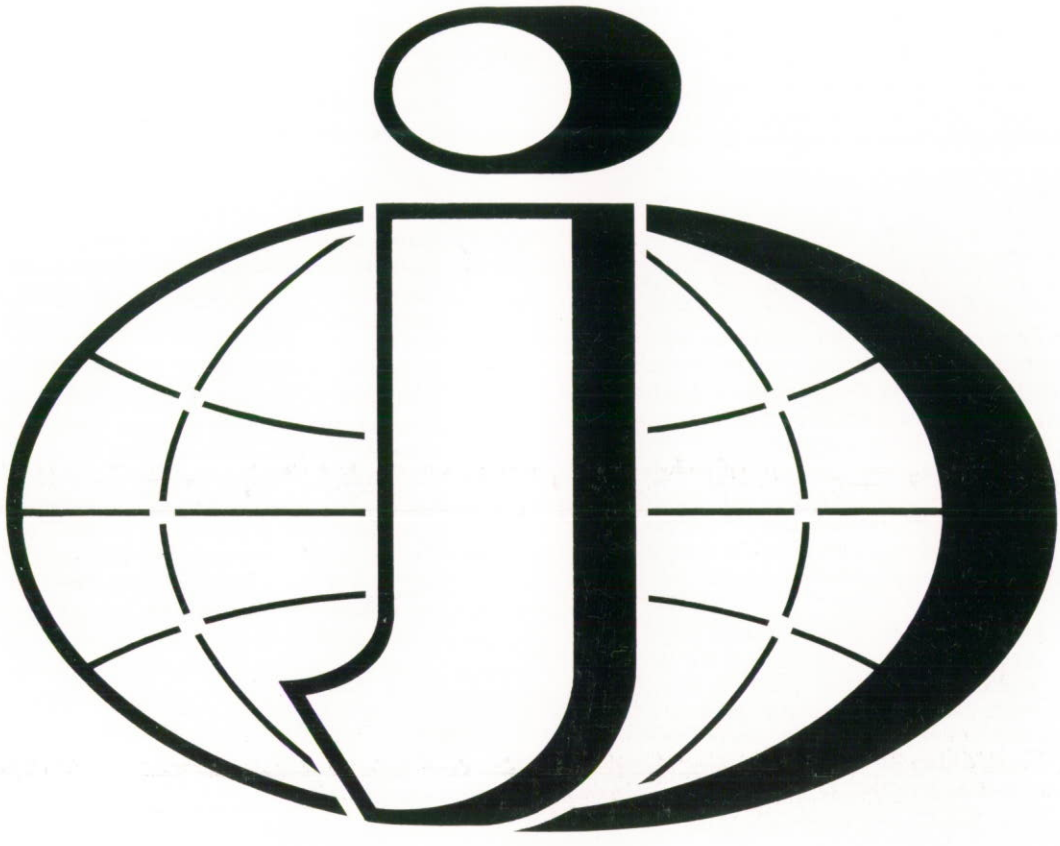

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Breathing is Life

COMPUTER PROGRAMS FOR CALCULATION AND STORAGE OF THE RESULTS OF LUNG FUNCTION TESTS

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(1) Respiratory Department, Bristol Royal Infirmary. (2) Department of Epidemiology and Community Medicine, University of Bristol.

Abstract

This paper describes a suite of computer programs which have been designed

a) to calculate the results of various lung function tests and predicted values using European summary equations and to produce a formatted printed output, suitable for inclusion in the patients' notes;
b) for the creation and updating of a data base of all lung function test results for retrospective research.

The programs have been written in Basic in a modular form, such that they should be compatible with other systems, with only minor modifications. They are easy to use and provide a rapid and clear presentation of the results.

Introduction

Computers are now accepted as part of the basic machinery required for the functioning of many respiratory departments and as a result, have found many useful applications. Generally, these fall into two categories – (1) Computers interfaced into equipment, either to run the equipment or for on-line data collection, and (2) as a general purpose device. This second category may include history taking (1,2), calculation and presentation of lung function results (3), and provision of an interpretative report (4,5).

We have devised a suite of programs (a) to allow the calculation of lung function tests in common use in our department and to present the results in a format acceptable for direct inclusion into the patients' notes and (b) to provide a data-base for use in retrospective research. This report presents the current working version.

Background to Programme Development

The lung function tests that may be performed at a single diagnostic session in this laboratory are listed in Table 1, and are divided into categories: those tests performed regularly (''Routine tests''), and those performed occasionally (''Special tests''). To limit the amount of programming and the overall length of the report form, only those tests performed routinely were included. The results of special tests and skin tests may be added to the report in a ''box'' provided.

We also designed a data-base of all patients' results to facilitate retrospective research. It is necessary to update existing files to include data not available at the time of testing, to create new patient files and to be able to interrogate the data-base.

The processing of the data is carried out on our laboratory computer (Minc-11/23 computer with LA-100 printer – Digital Equipment Corporation) immediately following completion of the tests. The data are entered by the technician who performed the tests, via a visual display unit (VDU) from specially formatted work sheets. The total time to input all the tests currently available, and to obtain a print-out is approximately 10 minutes, an average entry taking 2 to 3 minutes.

Table 1

Routine and special tests of pulmonary function performed at the Respiratory Unit, Bristol Royal Infirmary.

Routine Tests:

Forced Expiratory Volume in 1 second, Forced Vital Capacity, Expired Vital Capacity, Peak Expiratory Flow (Before and after Bronchodilator Therapy)

Total Lung Capacity
Functional Residual Capacity
Residual Volume
Inspired Vital Capacity

Transfer Factor (single-breath)
Transfer Coefficient

Flow Volume curves

Maximal expiratory and inspiratory pressures

Ear Oximetry (pre and post exercise)
Arterial Blood Gases
Mixed Venous Rebreathing PCO_2

Response to Treatment (ie Nebuliser Assessment)

Special Tests:

Progressive exercise (cycle ergometer)
Arterial Blood Gases before and after administration of 100% O_2
Methacholine/Histamine Challenge
Test for Exercise Induced Asthma
Ventilatory response to CO_2
Subdivisions of Transfer Factor
12 minute walk
Transfer Factor on exercise

Program Description

All the programs are written in Basic, to allow compatibility with other computer systems. The programs are in modular form, such that only the selected program is stored in memory. This reduces the amount of memory required to run the suite of programs to that of the largest, makes modification easier and allows additional programs to be added without greatly interfering with the rest of the programs. A flow diagram of the complete suite is shown in figure 1. The programme suite is divided into two sections, linked by a central menu – "MENU 1". In order to run the programs, "MENU 1" is displayed on the VDU, from which Section 1, Section 2 or Exit may be selected.

Section 1 – Lung Function Tests: On selection, a menu of tests available – "MENU 2" is displayed, from which the appropriate tests may be selected. With the exception of the "PRINT TO FILE" and "ADDITIONAL TESTS" programs, all programs generally follow the same format of a) data input, b) test calculations, c) calculation of predicted values and normal range, d) preparation of data for output, and e) return to "MENU 1". Each program contains, where appropriate, set limits for the input of data. If a variable is entered outside the set limits the operator is asked to re-enter the variable correctly. Predicted values, where appropriate, are calculated using the European Community for Coal and Steel (ECCS) standards (6) for subjects of European descent. Predicted values for children and non-European subjects (7) are also inlcuded. Normal ranges, rather than percentage predicted, are calculated as the predicted value plus or minus 1.64 standard deviations.

For a new patient, the program "PATIENT DATA/ SPIROMETRY" must be selected first, as this contains calculations for correction factors, and allows input of the patient's age, height and other data for use in the predicted calculations of the other programs. Provision to ensure that this section is selected first for each new patient is contained in all the other programs from this section. The "PRINT TO FILE" program is selected when all the data has been entered. All other programs in this section may be selected in any order.

The program "TRANSFER FACTOR" has the facilities to correct the result to a standardized haemoglobin concentration of 14.6 gm/dl (8). The "ADDITIONAL TESTS" program allows the operator to type in results of any special tests performed.

When all the data for a given patient has been entered, the operator selects the "PRINT TO FILE" program. This enters the data for each selected test into a pre-formatted "box" on the report form. If, however, a test has not been performed, the box for that test is omitted. Therefore, the length of the report form can vary from one to two pages depending on the number of tests performed (Fig.2).

For each patient, two print-outs are produced. Firstly, any number of copies of the report can be produced, which are sent out after the clinical report has been added. The second print-out is produced for departmental use by the reporting clinician. This reproduces some of the data included on the report, but also includes special information, such as single-breath residual volume, that is only likely to be helpful to the reporting respiratory clinician. Quality control data for transfer factor is also included. Space is provided for the technician to write any comments relating to the patient's co-operation and performance (Fig.3).

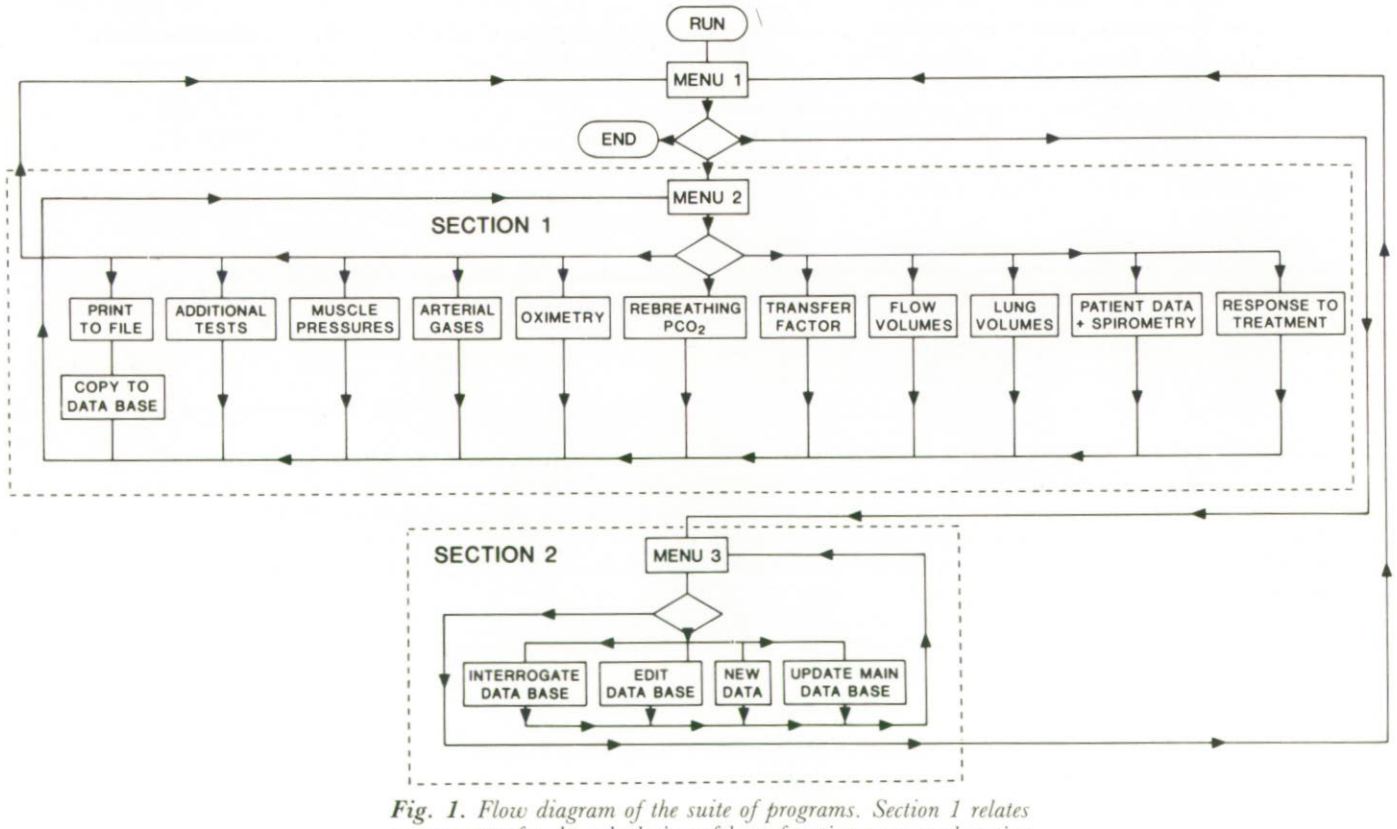

Fig. 1. Flow diagram of the suite of programs. Section 1 relates to programs for the calculation of lung function tests, and section 2 relates to the data-base.

RESPIRATORY DEPARTMENT

BRISTOL ROYAL INFIRMARY – (Tel. 22041 ext.2620)

Surname: Robinson
Fornames: John
Address: 27 Acacia Avenue
Clifton
Bristol
BS9 9GL

Number: 00123456
Consultant: Dr B Smith
Referred by: Dr F Jones
Test Date: 23-JUL-85
Report to:
Date Sent:

Height: 1.69 m
Mass: 55.8 kg
Age: 62
Sex: Male
Hb: 16.6 gm/dl

Ward: 21

		Result	Normal Range	Post-BD
Peak Expiratory Flow (l.min^{-1})	PEF	100	350 - 590	110
1 Sec. Forced Expired Volume(l)	FEV_1	0.9	2.2 - 3.8	1.1
Forced Vital Capacity (l)	FVC	2.1	2.8 - 4.8	3.0
Expired Vital Capacity (l)	EVC	2.0		3.3
	FEV_1%FVC	43	64 - 88	37
Flow at 50% FVC (l.min^{-1})	$MEF_{50\%FVC}$	55	169 - 327	55
Peak Inspiratory Flow (l.min^{-1})	PIF	150		150
Inspiratory Vital Capacity (l)	IVC	2.0	3.0 - 4.8	
Functional Residual Capacity (l)	FRC	5.3	2.4 - 4.4	
Residual Volume (l)	RV	4.4	1.7 - 3.0	
Total Lung Capacity (l)	TLC	6.4	5.3 - 7.6	
CO Transfer Factor (SI)	$T_{LCO,sb}$	6.6	6.3 - 10.9	
Transfer Coefficient (SI)	T_L/VA_{eff}	1.3		
Maximal Expiratory Pressure	cmH_2O	+125	> + 70	
Maximal Inspiratory Pressure	cmH_2O	- 75	< - 70	
Mixed Venous Rebreathing P_vCO_2	kPa	6.5	6.1 - 7.0	
Ear Oximetry (Rest)	S_aO_2	%	95.5	93.0 - 97.5
Post Exercise	S_aO_2	%	91.5	93.0 - 97.5

CONTINUES ON PAGE 2

All volumes are quoted as Litres BTPS.
BD=10min after 0.2mg Salbutamol by pressurised aerosol
Normal Range - (Mean predicted ±1.64 RSD) from ECCS Standards
Transfer Factor standardized to Haemoglobin of 14.6 g/dl

RESPIRATORY DEPARTMENT

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Report to:
Date Sent:

Height: 1.69 m
Mass: 55.8 kg
Age: 62
Sex: Male
Hb: 16.6 gm/dl

Ward: 21

		Result	Normal Range
pH		7.43	7.35 - 7.45
P_aCO_2	kPa	5.5	4.8 - 6.3
P_aO_2	kPa	10.1	11.9 - 13.2
S_aO_2	%	94.5	93.0 - 97.5

RESPONSE TO TREATMENT		1	2	3	4
Peak Expiratory Flow (l.min^{-1})	PEF	100	120	120	160
1 sec. Forced Expired Volume(l)	FEV_1	0.9	0.9	1.1	1.4
Forced Vital Capacity (l)	FVC	2.1	2.2	2.2	2.3
Expired Vital Capacity (l)	EVC	2.0	2.4	2.5	3.1
Cardiac Frequency (min^{-1})	f_c	75	78	78	80

1 - Baseline measurements
2 - 30 min after 2.5mg salbutamol
3 - 30 min after 2.5mg salbutamol
4 - 60 min after 0.5mg ipratropium bromide

ADDITIONAL TESTS

Skin Tests:- Histamine 10mm, Cat 15mm, Others negative.
12 minute Walk:- 1.123 km, 5.16 kmph, No Rests.
Methacholine Challenge:- PC20 = 2.34 mg/ml.

REPORT:

Reported by:- .....

All volumes are quoted as Litres BTPS.

Figs. 2a and 2b *Example of a full report of lung function results.*

The "PRINT TO FILE" program uses a temporary spool sequential file "REPORT" to store the print-outs. This allows the results from more than one patient to be entered and the reports stored for subsequent printing. To print the reports, the operator selects the "PRINT REPORT" program.

When the formatted print-outs have been written to the "REPORT" file, a selection of the data is formatted and transferred to another sequential file "TDATA", using the program "COPY TO DATA-BASE". This program is not accessible to the operator, its operation automatically following the running of the "PRINT TO FILE" program.

Section 2 – Database: The programs within this section generate two data-bases. A temporary data-base "TDATA" is used to store all patients' results generated within a two to four week period, and the main data-base "MDATA", contains every set of patient data. Via "MENU 3", the operator can update and edit "TDATA" for a specific patient using the program "EDIT DATA-BASE". This allows additional data to be added, and the data already stored to be checked. The "NEW DATA" program allows patients' previously reported data not currently included in the main data-base to be added to "TDATA". Access to both data-bases is limited to designated personnel by use of a security code system, therefore satisfying the requirements of the Data Protection Act.

The format of the data-base is preset with all unnecessary information such as decimal points removed, which reduces the size of memory required. This format allows the user to obtain print-outs of all or any desired part of the

LABORATORY SHEET

Surname: Robinson
Fornames: John

Number: 00123456
Consultant: Dr B Smith
Test Date: 23-JUL-85

Height: 1.69 m
Mass: 55.8 kg
Age: 62
Sex: Male
Hb: 16.6 gm/dl

WARD 21

Tests Performed by:- ADRIAN

SPIROMETRY:-

PEF	:-	100	FEV1	:- 0.90
FVC	:-	2.1	EVC	:- 2.0
FEV1%FVC	:-	43	FEV1%EVC	:- 45
EMPEY INDEX	:-	0.9		
MEF 50%FVC	:-	55	PIF	:- 150

LUNG VOLUMES:-

TLC	:-	6.4	FRC	:- 5.3
RV	:-	4.4	IVC	:- 2.0
ERV	:-	0.9	RV%TLC	:- 55

TRANSFER FACTOR:-

		1	2	3	Mean
TLco	:-	6.35	6.85		6.60
TL/VAeff	:-	1.28	1.32		1.30
VAeff	:-	4.96	5.19		5.07
RVsb	:-				3.95
VI%FVC	:-	84	86		85
VI%EVC	:-	88	90		89

TECHNICIANS COMMENTS

Fig. 3. *Example of the departmental print-out.*

NAME	UNIT No	DATE	PATIENT DATA	SPIROMETRY PRE +POST BD	LUNG VOLUMES	TLco	GAS	Pmus	SPECIAL TESTS	CLIN/CATH DATA	DIAG CODE
ALLSOPP	123586.	21JUL83.	632158 50.	1000619	.204436 55.	2809.		.120110.	11	.5	.13
BROWN	402176.	15APR82.	412165 47.	4302831	.343827 59.	4412.		99130.		.3 2	.30
JONES	412993.	05MAY84.	561164 57.	1201024 1301026	.	5718.	5694.	47 98.	1	.2	.10
SMYTHE	454665.	10AUG85.	622162 53.	1951533 2801836	.372811 44.	5716.			1	.2	.15
WILLIAMSON	432187.	01APR82.	371173 74.	6004154	.543011 65.	11420.	6198.			.1	.15

KEY: BD - Bronchodilator
Tlco - Transfer Factor
Gas - PvC02 + Sa02
Pmus - Muscle Pressures
Clin/Cath Data - Clinical and Cardiac Catheter data
Diag Code - Diagnosis Code

Fig. 4. *Section of the data-base, showing sections of data included.*

complete data-base. A section of the data-base is shown in Fig.4. Spaces are left where information is missing. The section marked "special tests", allows the operator to indicate that these non-routine tests have been performed – indicated by a "1". Space is also allowed for clinical information such as smoking history. These results are available from the patient's file if required. (The choice of indices included is based on the practice of this laboratory.) On a regular basis, when the editing TDATA has been completed, TDATA is combined into MDATA, using the "UPDATE" program.

The final program in this section is the "INTERROGATE DATA-BASE" program. This allows the user to obtain information on patient groups either by diagnosis code or by selecting an index, for example, to investigate all patients with a value below a predetermined level. Appropriate data can either be written to another file for subsequent analysis, printed or both, and these files can then be manipulated for subsequent statistical analysis or plotting. This program does not yet include any statistical or plotting facilities.

Discussion

The desirability of processing respiratory function test data by computer depends on a number of criteria, including the number of patients and the range of tests available. Prior to the implementation of section 1 of this program suite, processing of the data was carried out by staff using a programmable desk top calculator. This process required the technician to transcribe the results by hand onto a pre-formatted report form, a time consuming and expensive process, which probably had a high transcription error rate. In addition, the need for a data-base facility could not easily be satisfied. Until the introduction of section 2 of the program suite, the technicians were required to transcribe the patients' data onto pre-formatted sheets, which were then sent to another department. Here, the data were yet again transcribed, this time onto punch-cards, for use with the London University statistical service.

The suite of programs allows a more efficient use of departmental staff and reduces the error rate. However, interaction with a larger computer is still required if complex statistical tests are to be performed.

In setting up the present system, we have not included facilities for computer interpretation. This facility has been used to provide physiological interpretations (4,5), which may sometimes be misleading, especially if only simple tests are used. In this unit clinical reports are provided by senior medical staff, who interpret the results on the basis of clinical information provided. Computerisation of this process may not be as difficult as it sounds (9), but is a challenge we have yet to tackle.

The data-base system we have developed has provided a source of easily interrogated data, which can be used to investigate lung function patterns in various diseases and the relationships of various indices in different diseases.

Updating of patients' results can require frequent entering and searching of the data-base. This would, as the data-base increased in size, be very time consuming and would also increase the risks of corrupting the main data-base. The temporary data-base reduces this risk.

Future developments are planned to improve this system. These include on-line processing, particularly of spirometry and flow volume curves, and the linking of our data-base with those of other local departments.

Acknowledgement

We thank the Medical Illustration Department, University of Bristol, for the preparation of the figures.

1) Copies of the programs with full user documentation are available. Details upon request to Mr A.H. Kendrick. For National Health Service and University departments within the UK material is supplied at media cost.

2) This work was presented at the ARTP meeting at Cambridge in October 1985.

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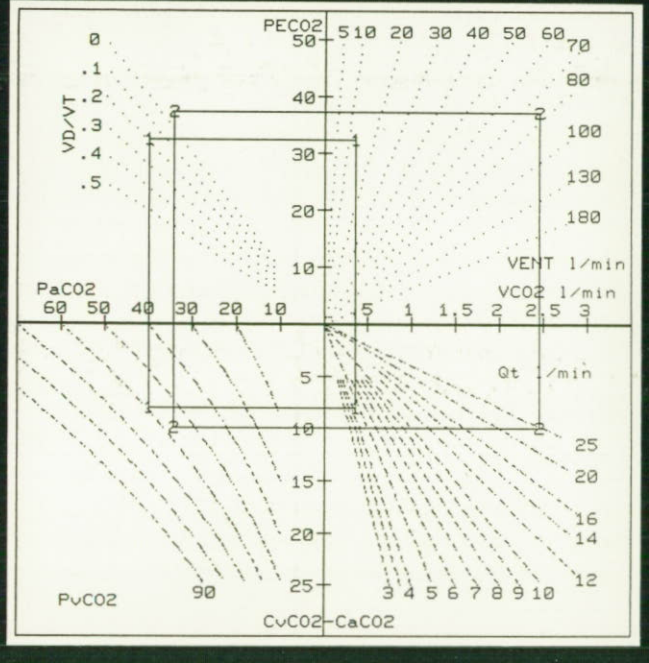

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BOOK REVIEWS

Adrian Kendrick

Physiology of Exercise: Responses and adaptations
D.R. Lamb
Collier Macmillan Publishers (London) 1984 489 pages
ISBN 0-023-67210-2

This book aims to describe and explain the functional responses and adaptations that accompany single or repeated bouts of physical exercise. It is a beginners' course, requiring no chemistry background, but suggests that some knowledge of human or animal physiology would be helpful.

There are nineteen chapters, eleven appendices, and a glossary. Following two introductory chapters, extensive reviews of the many physiological aspects of exercise physiology are covered, including energy metabolism, nutrition, skeletal and muscle function, cardiac and pulmonary adaptations, endocrine responses and neuromuscular function. In addition to the physiology, chapters on training and evaluation of exercise performance are included. The extensive appendices cover symbols, units, conversion factors and nutrition tables. The glossary is comprehensive.

The text is very readable throughout, with each chapter being well referenced. This is a very good book for anyone interested in exercise physiology, and will provide a slightly more up to date text than the excellent "Textbook of Work Physiology" by Astrand and Rodahl.

Pulmonary Function Testing: Principles and Practice
Eds: – Conrad S.A., Kinasewitz G.T., George RB.
Churchill Livingstone Inc. 1984 378 pages
ISBN 0-443-08182-4

This book, by American authors, is aimed at both medical and allied health students, and can be used as a reference guide by practising respiratory therapists, cardiopulmonary technicians and physicians. Contributors include chest physicians, a neurologist, a paediatrician and an engineer.

The book is divided into 3 sections and there are 3 appendices. Section 1 – "Physiological Basis", provides a physiological background for the understanding of subsequent sections. Coverage is adequate, with the exception of the chapter on gas transport, which is rather poor. Section 2 – "Techniques of Assessment" starts with a brief chapter on equipment, and is followed by chapters on lung volumes, mechanics, distribution of ventilation and perfusion, and gas diffusion. This section is well presented, and provides good detailed accounts of the various tests and techniques available for assessing lung function. Section 3 – "Clinical Application and Interpretation", includes chapters on the clinical interpretation of routine pulmonary function tests in adults, pulmonary function testing in children, exercise testing and disability evaluation, and sleep disorders and their monitoring. The chapter on sleep disorders and their monitoring is very useful, particularly as this is not covered fully in many other texts. The chapter on exercise testing is rather poor. The appendices cover symbols and terminology, normal values, and derivation of equations. The last two appendices are quite useful, although the appendix on the derivation of equations could have been covered in the main sections of the text under the appropriate chapters.

Although the text is fairly clear and concise, the order of the chapters is not always logical, and the referencing somewhat limited. This books appears to attempt an American version of Cotes' Lung Function, but I think it will be used more as a supplement to Cotes' book rather than as a replacement.

Recent articles from Thorax, British Journal of Diseases of the Chest and American Review of Respiratory Disease – April to August 1985. (Selected by Derek Cramer).

Thorax Vol 40

April (No 4) Effects of aminophylline on the human diaphragm. J Moxham, T Miller et al. p 288-292.

May (No 5) Changes in ventilation and its components in normal subjects during sleep. J R Stradling, G A Chadwick and A J Frew. p 364-370.

June (No 6) A self paced treadmill walking test for breathless patients. A Beaumont, A Cockcroft and A Guz. p 459-464.

July (No 7) Computer analysis of ventilation-perfusion scans for detection and assessment of lung disease. G H Burton, W A Seed and P Vernon. p 519-525.

August (No 8) Performance, ventilation and oxygen consumption in three different types of exercise test in patients with chronic obstructive lung disease. C R Swinburn, J M Wakefield and P W Jones p 581-586.

Gastro-oesophageal reflux and childhood asthma: The acid test. N M Wilson, L Charette et al. p 592-597.

British Journal of Diseases of the Chest

Vol 78 (No 2) Quantitative lung scintigrams and lung function in the selection of patients for pneumonectomy. A J Williams, R M Cayton et al. p 105-112.

Vol 79 (No 3) Fall in vital capacity with posture. S M Allen, B Hunt and M Green. p 267-271.

American Review of Respiratory Disease

Vol 131

May (No 5) Normal standards for an incremental progressive ergometer test. N L Jones, L Makrides et al. p 700-708.

June (No 6) Work of breathing in patients with chronic obstructive pulmonary disease in respiratory failure. B Fleury, D Murciano et al. p 822-827.

Vol 132

July (No 1) Breathing and oxygenation during sleep are similar in normal men and women. J R Catterall, P M A Calverley et al. p 86-88.

Prediction of ventilation at maximal exercise in chronic air flow obstruction. T A Dillard, S Piantados et al. p 230-235.

Aug (No 2) How many spirograms for a histamine challenge? G S Scott and M King p 268-271.

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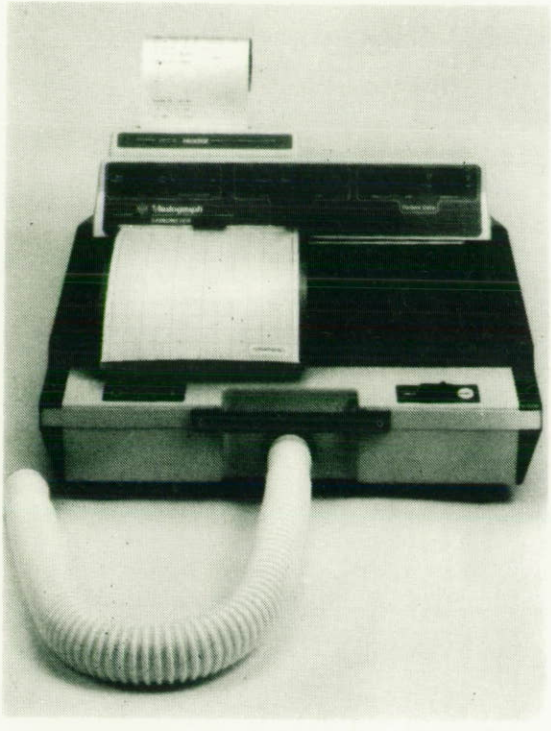

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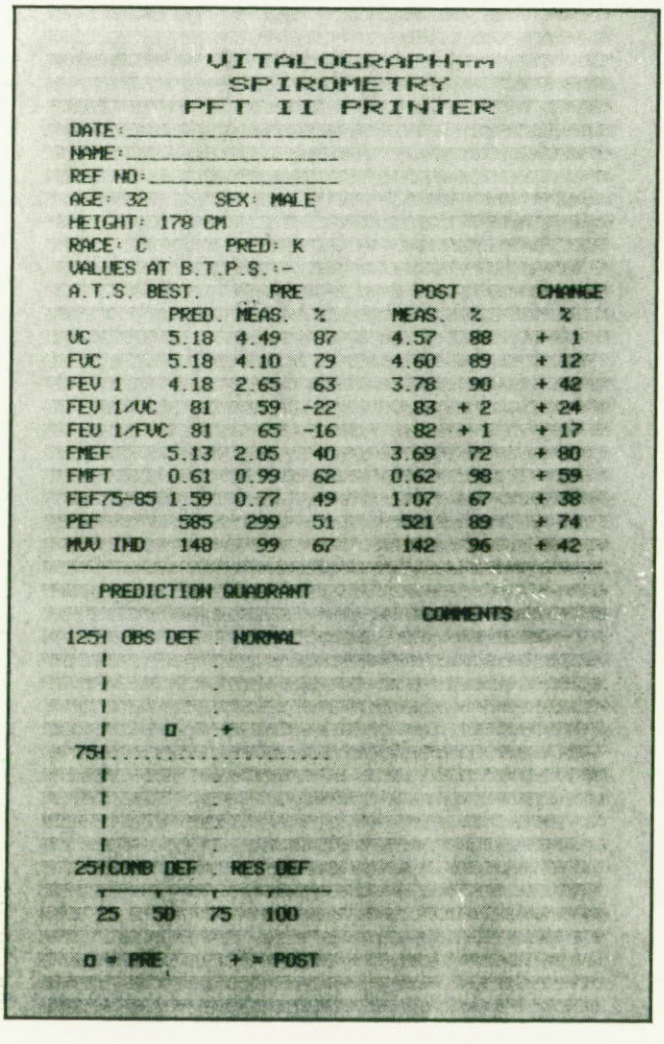

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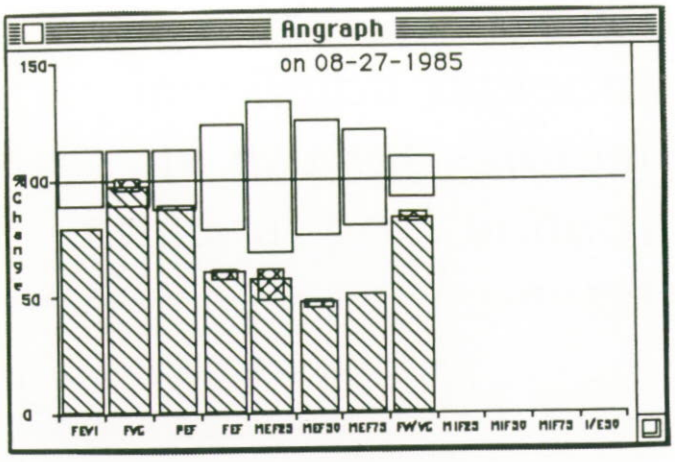

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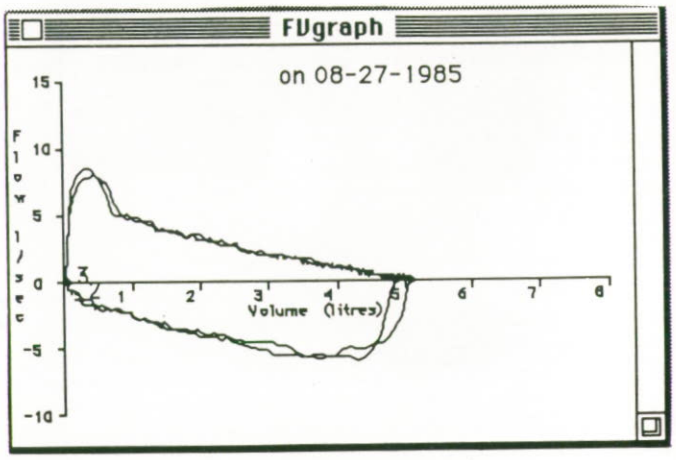

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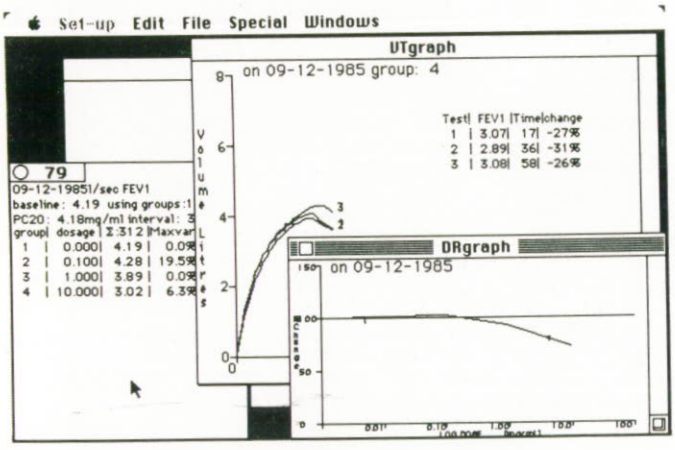

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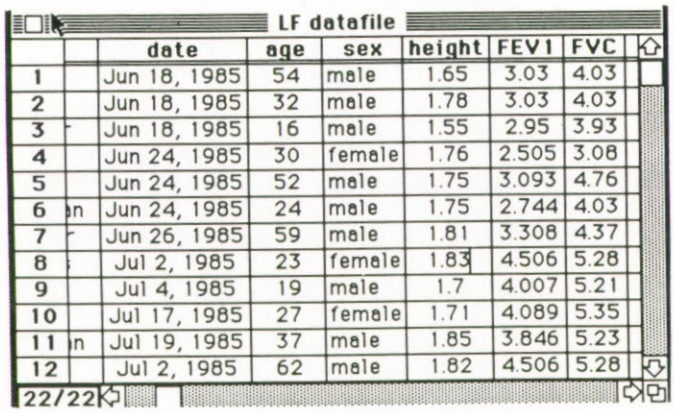

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2		Jun 18, 1985	32	male	1.78	3.03	4.03
3		Jun 18, 1985	16	male	1.55	2.95	3.93
4		Jun 24, 1985	30	female	1.76	2.505	3.08
5		Jun 24, 1985	52	male	1.75	3.093	4.76
6	n	Jun 24, 1985	24	male	1.75	2.744	4.03
7		Jun 26, 1985	59	male	1.81	3.308	4.37
8		Jul 2, 1985	23	female	1.83	4.506	5.28
9		Jul 4, 1985	19	male	1.7	4.007	5.21
10		Jul 17, 1985	27	female	1.71	4.089	5.35
11	n	Jul 19, 1985	37	male	1.85	3.846	5.23
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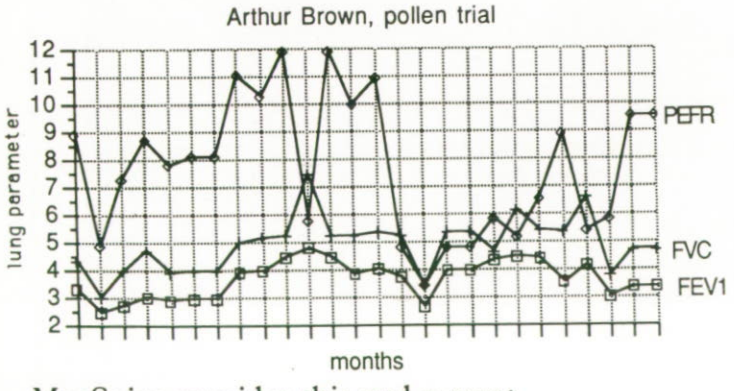

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TENTH ANNIVERSARY ANNUAL GENERAL MEETING

The Tenth Anniversary Annual General Meeting of the Association took place on the 4th and 5th October 1985 at Papworth Hospital, Papworth Everard and at Hinchingbrooke Hospital, Huntingdon. We owe grateful thanks to Sally Gough and her colleagues for organising an excellent programme, to the firms who sponsored the meeting and to the speakers for their interesting papers.

Scientific Programme
At Papworth Hospital

1. Computer programmes for calculation and storage of lung function test results. *Mr. A.H. Kendrick, Bristol Royal Infirmary.*
2. Computer workshop. *Mr. G.D. Shaw, Papworth Hospital.*

At Hinchingbrooke Hospital

1. Surfactant and adult chronic lung disease. *Dr. T.W. Higenbottam, Papworth Hospital.*
2. Relevance of respiratory water loss in asthma. *Mr. N. Cracknell and Dr. I.F.C. Hay, Papworth and Addenbrooke's Hospitals.*
3. Exercise testing, a user-designed system. *Mr. D. Parsons, Bolton General Hospital.*
4. Prostacyclin and primary pulmonary hypertension. *Dr. D.K. Jones, Papworth Hospital.*
5. Heart and lung transplantation. *Mr. J. Wallwork, Papworth Hospital.*

A number of posters were also known.

The following firms generously sponsored the meeting.

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*PK Morgan Ltd
Rigel Research Ltd
Vickers Medical
Vitalograph Ltd
Vygon (UK) Ltd

*Also exhibited at the meeting

Chairman's Report Sue Hill

In this tenth Anniversary year, I would like to begin by thanking the past Chairmen who have served the Association since its foundation, namely Len Smith, Sally Gough and Derek Cramer, together with everyone else who has contributed towards making the ARTP into the successful recognised body it is today. The last ten years have seen many changes, and we look forward to the next ten years as we continue to grow, develop and progress.

AGM and Spring Meeting
Thanks are further due to Sally Gough and her colleagues for organising this AGM and for providing an extremely interesting and varied programme – from computing to surfactant to heart and lung transplantation, giving us some insight into the many areas of interest here in Cambridgeshire. May I extend the Association's grateful thanks to all the speakers and to the catering staff for both the excellent meal last evening and today's buffet.

The Spring Meeting of the Association was held at the Leeds Royal Infirmary and I would like to thank Geoff Wade and his colleagues for organising the meeting which included some excellent papers.

We are as always extremely grateful to the commercial organisations who have contributed generously towards the cost of both the Spring Meeting and the AGM. I would like to thank all the firms that have supported the Association over the past ten years and look forward to their continued support in the future.

It was encouraging to see more presentations from the membership at both this AGM and the Spring Meeting. I hope that this will continue and hope to see many more members taking an active role in the meetings. I recently spent a very interesting day at the North West Region Physiological Measurement Seminar, where the programme consisted almost solely of presentations by technical staff so I look forward to the day when this happens at the ARTP meetings. Papers do not have to be exclusively the results of research studies, but may present a technique, a case report or even a synopsis of a particular disease.

I shall now endeavour to highlight a number of salient points of the last year, which will not be mentioned in the reports given by other officers.

Charitable Status The Association eventually became a registered unincorporated charity on January 21st, 1985, under the Charities Act of 1960. Our registration number will be appearing shortly on all ARTP correspondence. Charitable status has many obvious advantages to the Association, including exemption from Corporation Tax. However, it also involves the personal liability of Executive Committee members. This has prompted us over the last six months to look at the Constitution in greater details, the general day to day running and the finances of the Association.

Many of our discussions over the last year have been concerned with ways of reducing our expenditure and of increasing our income. The current subscription fee does not cover the ongoing expenses of the Association without even considering the costs of meetings and production of Breath. We intend to ensure that subscriptions are kept at a reasonable level but the future may have to see the introduction of a small registration fee for our meetings.

Discussion with the British Thoracic Society The Association has still not held any formal discussions with the British Thoracic Society. However, recently I have written officially as Chairman of the Association to the President of the BTS suggesting a meeting of the two groups to discuss matters of mutual interest, particularly with reference to the ARTP's educational policies. This was also

supported by a letter from Dr. Hutchison, who emphasised the importance of bringing our educational programme to the attention of clinicians in the field of Thoracic Medicine. It is obviously crucial that joint consultations between medical, scientific and technical staff take place to ensure that acceptable guidelines are drawn up for the further education and training of technical staff. The ARTP and its activities are soon to be discussed by the BTS Council.

Assistant Editor I rather sadly have to report that we are losing Janie Jones, our Assistant Editor, and past treasurer, who is shortly to join a medical publishing company in London. As you may be aware Janie has put many hours into the production of Breath over the years and was instrumental in changing its format to that which we receive today. Breath is certainly a credit to the Association and I am sure that Dr. Hutchison would agree that much of its success lies with Janie.

I should like to thank Janie on behalf of the Association for all the effort she has put into the Association over the years. It has been greatly appreciated. I wish her every success in her new post, though we still expect to see her at ARTP meetings.

Public Relations Officer I am happy to report that Gillian Lowe has become Gillian Manning – may I extend the Association's congratulations to Gillian. Gill is, in fact, relinquishing the post of Public Relations Officer, but will be remaining as Education Chairman. I will take this opportunity of thanking Gillian for initiating much of the groundwork required to establish this role within the ARTP and for her success at raising sponsorship over the past two years.

New Positions The position of Assistant Editor is to be filled by Adrian Kendrick from Bristol and we are all grateful to him for offering to take this on, which may seem at present a rather daunting task. Penny Wright from Walsall has agreed to be the new Public Relations Officer.

Finally, I should like to end by thanking all members of last year's Executive Committee for the hard work and effort they put into the Association and for sitting through rather long agendas and getting home even later. Many thanks to: Dina Muirhead, our secretary; Gloria Holbrook, our treasurer; Derek Cramer, Donald McDonald, Carole Cummins, Sonia Jackson, our membership secretary, Gill Manning, our PRO and Education Committee Chairman and finally Sally Gough, who not only does an excellent job as FAMT secretary but is representing FAMT and therefore ARTP at many higher level committees. It is encouraging to know that the ARTP's views are so well represented. Lastly, I must as always thank Janie Jones and Duncan Hutchison, our Editorial Board, for their sterling work in the production of Breath. I am sure all of your collective efforts are greatly appreciated.

1. *Re-organisation of the Council with Regional Secretaries*
   Members within each of the 14 Regional Health Authorities, Wales, Scotland and Northern Ireland shall nominate and elect a representative to become the Regional Secretary. This person shall be responsible for distributing information and communicating with the Secretary of the Association. They may also suggest items for inclusion on the agenda of Executive Committee meetings, which they may be asked to attend in person. A list of all Regional Secretaries will be published in the Association's Journal.

2. *Restructure of the Executive Committee*
   The Executive Committee shall consist of the following voting members:

   6 ELECTED MEMBERS
   Chairman
   Secretary
   Treasurer
   3 other members

   6 EX-OFFICIO MEMBERS
   Chairman of Education Committee
   1 other representative of the Education Committee
   1 FAMT representative
   1 representative from Editorial Board
   Public Relations Officer
   Membership Secretary

Proposed Changes to the Constitution

Our existing constitution was written before the foundation of the Association over ten years ago. Although it has served us well over the years, the time has come to re-think certain aspects, particularly in view of our recently acquired charitable status.

Being registered as an unincorporated charity under the Charities Act of 1960 means that serving members of the Executive Committee become the trustees of the charity. In doing so they become personally liable for breaches of charity including misappropriation of trust money, slander of goods and incurring debts beyond income.

After discussion with a solicitor it appears that, in order to minimise risk, several changes are required in our constitution. These include:

1. All decision making should be made jointly by Executive Committee members, (both on financial and other matters) to ensure that we are conducting our business as befits a charitable organisation.
2. All parties involved with incurring debts should become full Executive Committee members with joint liability.
3. A general tightening up on the day to day running of the Association is required.
4. Officers of the Association should not all retire at the same time and other members should serve longer terms of office.

It is also necessary to re-examine the role of the Council. The original purpose of the Council was to provide a forum whereby representatives from all regions of the country could express their views. Some concern was expressed as far back as the foundation meeting that the ARTP might become predominantly a London-based organisation, though this has not, in fact, turned out to be the case. Over the years Council meetings have been poorly attended, barely reaching a quorum on some occasions. The majority of those who do attend are members of the Executive Committee rather than the regional representatives for whom the Council was intended. This has resulted over the years in the slow erosion of the powers originally given to the Council. In fact, ordinary members have played a more active part through organising and participating in our Scientific meetings and joining in the discussion at the AGM which appears now to fulfill the role originally intended for the Council. A further factor arises from the financial state of the Association. The cost of travel to Executive and Education meetings has escalated along with the workload and the expense of a meeting which no longer fulfills its original purpose no longer seems justified.

The following changes are therefore proposed. The Secretary welcomes comments from members of the Association.

The 6 elected members shall be elected by the membership at the Annual General Meeting following nominations for any vacancies that arise.

The other 6 Ex-Officio members shall be elected by the Executive Committee to their specific posts. Their election shall be confirmed annually.

The 3 officers of the Association (Chairman, Secretary and Treasurer) shall be elected for a 3 year term of office and shall not all retire together. The Chairman shall have been an Executive Committee member for the 2 preceding years.

The 3 other members shall be elected for a 2 year term of office.

Full reports on all activities by members of the Executive Committee shall be given at every meeting.

Education Committee Report

Gillian Manning

The Education Committee has worked hard over the last year and has taken great strides forward in many areas:

1. *Assessment of In-Service Training:* All Heads of Respiratory Physiology Departments have been circulated with the Guidelines for the National Assessments in Respiratory Physiology which are taking place in 1986. The Assessment will have three parts – practical, written and oral.

   The National Training Committee is planning to launch the Assessment of In-Service Training in Summer 1986 as all the professional bodies will have an organised examination by that time.

2. *Information Leaflets:* The Education Committee is writing information leaflets to accompany the National In-Service Training Manual. These are intended as a guide to Supervisors and Students and should ensure all students are trained to the same level.

3. *Standardization of Lung Function Testing:* The Education Committee has been preparing a questionnaire relating to how lung function tests are performed and reported within individual laboratories. The questionnaire has taken longer to produce than anticipated but should be circulated within the next month.

4. *Syllabi: BTEC National and Higher National Certificate:* The Committee have placed priority on reviewing the Respiratory Physiology content of the National Certificate; a draft has been produced but further work is needed.

5. *Updating of the In-Service Training Manual:* The Respiratory Physiology section of the manual was updated and submitted to the National Health Service Training Authority. However, the National Training Committee is to hold back the release of the revisions to coincide with the launch of National Assessments in 1986.

6. *Careers Leaflet:* The Careers Leaflet has been re-written and printed and is available from the Secretary, Mrs. Muirhead.

Finally, I would like to thank the Members of the Education Committee for their hard work on behalf of the Association and Mrs S Gough in particular for her work as Secretary.

Report from the Membership Secretary:

Sonia Jackson

208 subscriptions have been received this year (189 Full Members, 9 Junior Members and 10 Associate Members). There are 39 new Members. 38 Members have not renewed their subscriptions and having been sent reminders, will have to be removed from the list of Members.

I would be grateful if Members who wish their correspondence to be sent to their home address, could inform me of their business address and region. Members who are moving, should inform me of their new address as soon as possible.

The full voting membership shall be notified of all re-elections and vacancies not less than 8 weeks prior to the AGM. Any nominations then arising shall be proposed and seconded and submitted to the secretary of the ARTP 6 weeks prior to the AGM. The full membership shall be circulated with all nominations and may either cast their vote in person at the AGM or by post.

Thus the full membership will participate in the election and not just the Council as at present.

Finally, I am grateful to all of those who have paid their subscriptions on time; I would ask you to continue to persuade your colleagues to join the Association and to support the body that does so much for our profession.

A Message from Jane Jones

I should like to take this opportunity to thank the membe of the Executive Committee and the Association for t gifts that were so kindly presented to me at the te anniversary celebrations. They were such a surprise t I was dumbstruck!

Although I shall remain a member of the Association, will regretfully have to relinquish my interest in BREATH. Dr. Hutchison and I wanted to make this a truly *professional* scientific journal and when John Griffiths said at the tenth anniversary meeting that it had a "touch of class", I was so thrilled because it seems that we may have actually achieved some of our aims.

In spite of my sadness at leaving, I shall hand my glue pot over to Adrian Kendrick with confidence. I am sure that the journal will flourish with new enthusiasm and ideas. I hope that members will support him and continue to supply the excellent articles that we have published so far. Do ask your medical staff to write for you – they don't mind at all.

May I also take this opportunity to thank our past contributors and advertisers for their support; our printer Mr. Terry Boughton and his staff, without whose advice and cooperation I could never have managed and most of all my thanks to "Hutch" for his professionalism and unfailing good humour in many a sticky situation over paste-up sheets and revolting black coffee!

Last, but by no means least, I should like to thank my own staff and the Administrator of The London Chest Hospital for allowing me the time to achieve all that I have.

Thank you all very much.

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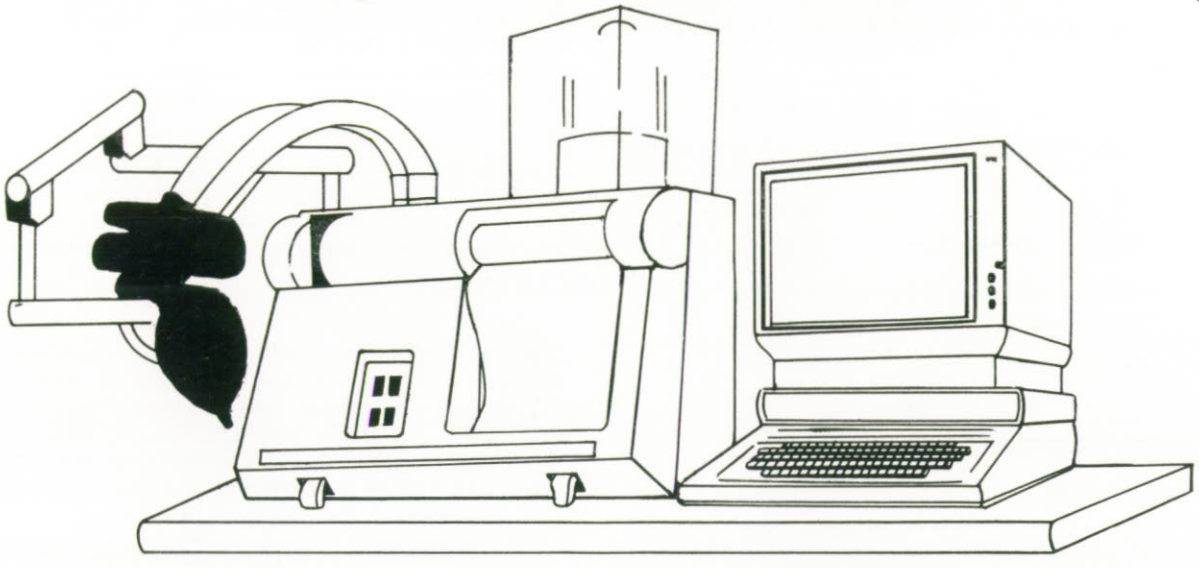

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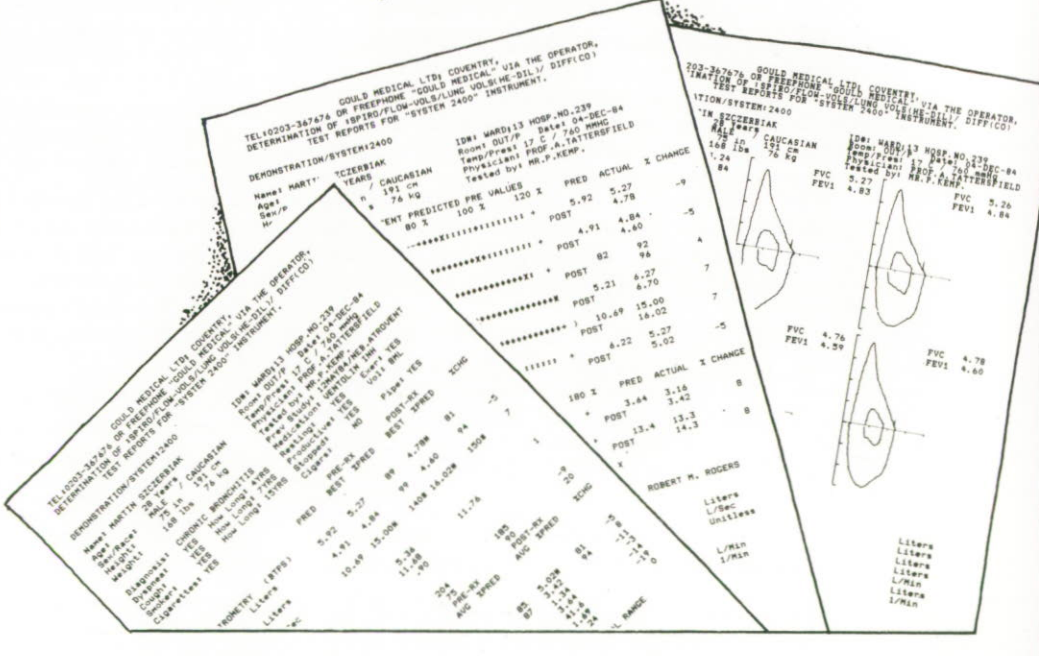

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Treasurer's Report Mrs G. Holbrook

I would like first of all to thank Gillian Manning and Jane Jones for their great efforts in acquiring a large portion of our income. The last financial year was a good one for us but unfortunately we were not able to maintain the momentum. However, given the present economic climate we did reasonably well.

Subscriptions were reduced due to loss of members but I hope that this will be rectified in the coming year. Donations were also reduced partly because of the decision not to hold an exhibition at the Spring meeting and partly due to the lack of funds available to our exhibitors. We rely very much on the firms and I would encourage all Members to visit their exhibitions and take a real interest in their products. It takes a good deal of time, effort and expense for them to exhibit their products and their donations help to pay our meeting expenses.

All areas of expenditure have increased and we must look for ways of reducing our costs; we will shortly be obliged to ask for an increase in the annual subscription. As we are now a Registered Charity and tax exempt, I shall be looking for new ways to invest our money fruitfully and any ideas are welcome.

STATEMENT OF INCOME AND EXPENDITURE

1st April 1984 to 31st March 1985

EXPENDITURE		INCOME	
Travel	1,533.91	Subscriptions	1,224.37
Catering	1,288.54	Donations	2,556.00
Postage & Stationery	1,050.09	**Breath**	2,718.75
Breath	1,985.25	Miscellaneous	189.00
Miscellaneous	192.85	Deposit Account Interest	45.62
Excess Income over Expenditure	683.10		
	6,733.74		6,733.74
Bank balance 31.3.85	4,396.46	Balance brought down	685.10
Deposit account 31.3.85	745.50	Bank balance 1.4.84	3,756.98
		Deposit account 1.4.84	699.88
	5,141.96		5,141.96

Breath: Editor's Report

Duncan Hutchison

Jane Jones, our Assistant Editor is unfortunately leaving to take up a full-time post in publishing. We owe her very grateful thanks for alll her hard work on behalf of the Journal. She has played a large part both in the editing of the Journal and in raising the advertising revenue, both very time-consuming tasks. We owe it largely to her that the Journal has been produced on time and remains in positive financial balance. I am grateful to her for her kind remarks – we have certainly had some amusement and learnt a good deal about the business. I wish her the very best of fortune in her new career. I welcome the future cooperation of Adrian Kendrick as Assistant Editor and of Penny Wright who will take over the advertising side.

Breath continues to appear thrice yearly and contains original articles, reviews, notes on current affairs and ARTP news. The correspondence column is open to all, whether ARTP members or not. Original articles are of particular importance to the Journal, which should be the major outlet for reporting technical advances in our field. Articles from other branches of medicine and technology are welcomed.

We owe grateful thanks as always to our printer, Mr. Boughton and the staff of Stevens Brothers for their cooperation and for maintaining a high standard of production, to our contributors for their many excellent articles and to the many commercial firms who have taken advertising space, thus ensuring that Breath remains in a financially sound position.

Examination Results

HTec: Miss Laura Watson (Trent)
Mrs. M Ward (Trent)
Mrs. Karen Wardle (Mersey)
Mr. David Richards (Wales)

OTec: Mr James Lucas (Wales)

Promotions

Miss Susan Revill: Chief Physiological Measurement Technician (Trent)

Congratulations to all the above.

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.

Applications for advertisement space and for rates should be addressed to: Jane Jones, Respiratory Laboratory, London Chest Hospital, Bonner Road, London E2.

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