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ARTP | Association for Respiratory Technology & Physiology

Inspire

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FIRST WORD

VOLUME 23, ISSUE 1. APRIL 2022

Welcome to the first **Inspire** of 2022. You will note, perhaps, a more slimmed down edition than of late. This is primarily due to the shift in conference time this year, from the usual late-January to early-May. This means that the once traditional festive pastime of checking that abstracts have been submitted and posters being suitably prepared has now shifted to the Easter/Passover/Ramadan period (this year). The e-poster deadline of Bank Holiday Monday ensured authors were kept on their toes! The once eagerly anticipated April edition conference abstract section should now appear in the August edition of **Inspire**.

So the ARTP conference will take place soon, face-to-face in the balmy environs of Leicestershire. Does this mean bracing January conditions in Blackpool, Telford etc. are ruled out for future conferences? I have no idea, however I am grateful to our Chair, Julie Lloyd, who has given a flavour of what to expect this time in her 'Word from the Chair'. Similarly, the manufacturers are no doubt keen to display their new products and updates face-to-face and some have provided Matt with a taster in 'On the Blower'.

I often end 'First Word' with a sentence to thank the contributors but for this issue I am moving it up the agenda, for it is they who create **Inspire** and while putting each issue together I am struck by the effort they make to provide informative and entertaining articles. 'Top Forum' is a round-up of the most important topics raised on the ARTP forum since the previous issue of **Inspire** (so, 4 months worth) and Harry Griffin provides a concise, balanced and witty overview of what Prof. Cooper recently described as *"an asset beyond the bounds of what was ever imagined when it was set up over 20 years ago!"*. 'Fresh Air'; James Stockley and the ARTP Research and Innovation set out *"to communicate novel trends in research"* and in this issue again they present pilot data from an ongoing study where cardiology crosses over into sleep. 'How it works', an idea raised with Kevin Hogben at an ARTP conference which he has continued to deliver with much effort, knowledge and images which are not without the odd associated formatting conundrum. This leads me to the Editorial committee, who pick up errors, typos, grammar and generally point out if something makes sense (or not). This is all voluntary and the response times and responders can therefore be varied but are often swift (and unanimous). In the latter case we have the final article not yet mentioned; Hayley Capewell's career journey providing a much needed tonic in early 2022.

My thanks to all. I look forward to seeing you at Conference and please do let me know if you have any ideas for future articles or regular features.

Aidan Laverty

Inspire@artp.org.uk

A WORD FROM THE CHAIR

Julie Lloyd

ARTP Honorary Chair

Welcome to this edition of Inspire Journal and spring is most certainly in the air. Hopefully, many of you will have had a few days break at Easter and managed not to eat too much chocolate (is there really such a thing as too much chocolate?).

This edition is usually the first one after our Annual Conference and is where I would review the sessions from our Annual Conference and discuss about plans for our next Conference. More recently, our Conferences have been held later in the year and as virtual events due to the restrictions of the Covid pandemic. Whilst many of the Covid restrictions have been removed, I know many of us continue to battle long waiting lists, patient backlogs and equipment shortages that make our work challenging. On a more positive note, this year I am delighted that the ARTP Conference will be returning as a face-to-face event on 5th and 6th May at Jurys Inn, Hinckley, Leicestershire. Given the exceptional quality of the program this year, I am sure many of you will have already booked your attendance and I am really looking forward to seeing you there. For those of you that have not attended a Conference previously or for those who have forgotten, this should give you a taste of what to expect!

However, back to the business of Inspire and a very packed edition it is. The ARTP Forum continues to be as lively and stimulating as ever and Dr Harry Griffin, Lead Respiratory Physiologist at Hampshire Hospitals NHS Foundation Trust has pulled together the most popular topics and responses that have been raised on the ARTP forum over the last few months. I would encourage all ARTP members to sign up to and engage with this really

useful resource for discussion, debate or just answering that leftfield question that you just can't find the answer to.

In this edition our very own resident respiratory archivist, Kevin Hogben, has produced another excellent article documenting the history of the measurement of airways resistance using a body plethysmograph, which leaves the reader with a number of interesting ideas to ponder. Dr James Stockley, ARTP Research Chair presents a contribution from Cardiology at the University Hospitals Coventry and Warwickshire NHS Trust about the Obstructive Sleep Apnoea and Cardiac Arrhythmias (OSCA) study. This is a study investigating the arrhythmia incidence/burden in an OSA population using an implantable cardiac recording device, termed an ILR, which already has preliminary data that looks extremely promising.

This edition also has another of our excellent occasional articles exploring the professional journey that respiratory and sleep scientists have followed to achieve their current post. Hayley Capewell, a Senior Respiratory Clinical Physiologist working at University Hospitals of Derby and Burton, charts her 'less conventional' career pathway that led her to becoming a qualified respiratory and sleep scientist. In her article, Hayley stresses how important the support from her team was in achieving her success, particularly her supervisor and mentor, Julie McWilliam. Having been fortunate enough to have had some excellent supervisors and mentors on my journey (Professor Martin Miller and Trefor Watts, thank you!), this demonstrates the impact each of us can have on the future of our profession when we support our trainees and gives me great confidence in the future of our excellent profession.

That just about brings this 'Word from the Chair' to a close. As always, I would encourage you to support ARTP and the wider profession in whatever way you can. If there is any way in which ARTP can support you more effectively, I would always be delighted to hear from you. I look forward to seeing you all at Conference. Until next time, feel free to contact me at chair@artp.org.uk.

On The Blower

Matthew Rutter
Alan Moore
Brendan Cooper
Ian Cliff
Peter Moxon

In this edition of on the blower we have product updates and services from Love Medical and Vitalograph. Philips also have an update for the safety notice relating to ventilators, CPAP and BIPAP devices. With the conference moving to May, the August edition of On The Blower will focus on news from the conference.

It has been decided this year that the usual manufacturer survey and industry awards will happen in a different format. As services are still having interruptions due to the impact of Covid and many places are not quite business as usual, it was felt to be more appropriate to show our appreciation for the continued support from our industry partners. If your service has had support from an individual or team that you feel warrants highlighting then please let us know by contacting us by email at manufacturersliaison@artp.org.uk

Finally, it is the end of an era. Manufacturers Liaison Committee (MLC) have confirmed the news that unfortunately Alan Moore has decided to step down from the committee. On behalf of the ARTP we would like to personally thank Alan for all his decades of hard work and continual support as an important part of the MLC. Alan has always used his network of industry contacts, experience, knowledge and investigative nature to find out the hottest news in the world on respiratory physiology measurement and in doing so has been a huge support to the membership and industry alike; from improving the standards expected of equipment to the interesting articles written on medical devices.

Lovemedical
Cardiopulmonary Diagnostics

We are looking forward to attending the conference in May, it is going to be a great opportunity to meet lots of new people as well as touch base with some of our existing customers.

Alongside our range of CPET and Lung Function systems which we have been supplying for over 14 years, we have a number of exciting new products and partnerships which we are hoping will further develop our product catalogue to give our customers a more complete solution.

We are pleased to announce that we have now partnered with Circassia to add FeNO by NIOX to our product offering.
This is an exciting partnership with the global leaders in FeNO testing and we are looking forward to showing you how our products integrate to give you a complete solution for your Respiratory Labs.

We are also excited to be showcasing another new addition at the conference, the Minibox+. This is the first desktop, gasless, and cabinless device for lung volumes as well as spirometry and diffusion.

With the innovative system, lung volume measurements can be achieved with just 60 seconds of tidal breathing.

If you would like any more information on what we have to offer, or you would like to have a demonstration of any of our products then please contact us now.

https://www.lovemedical.com/
Email: sales@lovemedical.com
Phone: 0161 976 2744

Both products will also be featuring on our stand at the Conference in May!

PHILIPS

I would like to take this opportunity on behalf of Philips to provide ARTP members and other respiratory societies an update on the Field Safety Notice 2021-05-A (ventilators) and 2021-06-A (CPAP and BiPAP devices) issued by Philips in June 2021.

This remediation is driven by our primary focus to ensure safety of our patients is at the centre of everything we do. I am pleased to say that the distribution of devices to various hospitals both in the United Kingdom and Ireland is in progress and we expect to continue this through to the end of 2022 when we hope to conclude.

We will be at the ARTP conference in Hinckley, Leicestershire and will be available to discuss what is new and answer any questions regarding Philips devices, we look forward to seeing you there.

As always if you have any questions our teams at Philips are here to support you and I would personally like to say a big thank you for your support during the ongoing remediation. We look forward to teaming up again in 2022 and I wish you all a successful year ahead.

Regards,
Mark Leftwich
Managing Director UK&I

https://www.philips.co.uk/healthcare

SCHILLER
The Art of Diagnostics

As a relative newcomer to the UK with our lung function equipment we wanted to give a brief introduction to Schiller and Ganshorn.

Founded in 1974 Schiller has become a successful group with around 1200 employees, 30 subsidiaries and a global sales network. Today, SCHILLER is a world-leading manufacturer and supplier of devices for cardiopulmonary diagnostics, defibrillation, and patient monitoring as well as software solutions for the medical industry.

Ganshorn was established in 1982 and over the years have succeeded in building up a complete spectrum of pulmonary function diagnostic devices, growing the company and developing the products over time with new and innovative features in the market.

At a time when pulmonology and cardiology are moving closer together, smart and combined solutions are required. Both companies had recognised this market need early on and the next major step was achieved when Ganshorn became a wholly owned Schiller Group business in 2019 enabling joint resources for further development in the cardio-respiratory market. Since then, GANSHORN has been manufacturing medical equipment for the entire spectrum of pulmonary and cardiovascular diagnostics.

With the development of SpiroScout, GANSHORN opened new perspectives for lung function diagnosis based on simultaneous flow and respiratory gas determination. Our systems for spirometry, body plethysmography, Spiro-Ergometry, CO diffusion and aerosol inhalation are market leading, and meet and exceed the current technical and medical standards.

Customers all over the globe appreciate not only the robustness and precision of our devices, but also the simplicity of the software. If you have not already heard about us, then please take some time to visit and say hello at the upcoming ARTP conference.

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Vitalograph®

A Global Leader in Respiratory Diagnostics

Looking forward!

We are all looking forward to seeing everyone together again at the ARTP Annual Conference, back at Jurys Inn Hinckley Island this summer.

New Products – Expanding Range

We are looking forward to showing customers this year our expanding range of respiratory diagnostic solutions – from respiratory monitors, through spirometers, all the way up to portable and laboratory based full pulmonary function testing devices.

Come over to our stand to speak to one of our experts as we'd love to hear about how your service has changed to meet new demands and tell you about our new products and solutions.

We're now on Facebook!

We're very pleased to have expanded our social media reach so you can now connect with us on **Facebook**. (https://www.facebook.com/VitalographUK)

Drop in and like our Facebook page, we'll answer any questions you have on all things spirometry and respiratory. We'll also keep you up-to-date with product information, healthcare news, and of course we'll have special offers from time to time.

See you over on Facebook!

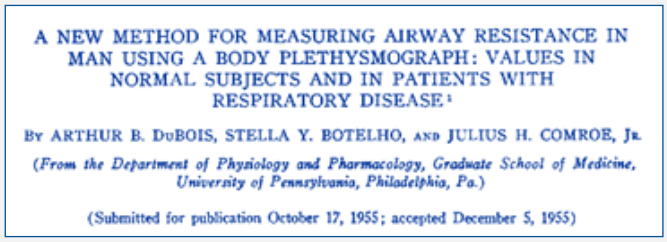
Enquiries and Updates

Contact us on **01280 827110** or **sales@vitalograph.co.uk** for further information on our respiratory solutions.

How it Works

By Kevin Hogben

Body Plethysmography – Quiet Breathing – Panting Techniques



A NEW METHOD FOR MEASURING AIRWAY RESISTANCE IN MAN USING A BODY PLETHYSMOGRAPH: VALUES IN NORMAL SUBJECTS AND IN PATIENTS WITH RESPIRATORY DISEASE[1]

By ARTHUR B. DuBOIS, STELLA Y. BOTELHO, AND JULIUS H. COMROE, Jr.

(From the Department of Physiology and Pharmacology, Graduate School of Medicine, University of Pennsylvania, Philadelphia, Pa.)

(Submitted for publication October 17, 1955; accepted December 5, 1955)

The original paper, from 1955, by Arthur DuBois et al.[1] explored both quiet breathing and panting methods.

The "method" discussed was as follows: Airways Resistance (R) is the ratio of the Alveolar pressure (Pa) to Airflow ($\dot{V}$) at a particular time. The Airflow was measured easily with the pneumotachograph, and the method of resistance they presented in the paper used the determination of the Alveolar pressure as it is present during airflow.

The principle used:

1. The subject sits inside an "air tight" box (body plethysmograph) similar to those used to measure the volume of air in the lungs or abdomen by application of Boyle's law using the relationship of volumes and pressures.
2. If there is no airway resistance, then the alveolar pressure would be equal to the ambient pressure in the plethysmograph throughout the respiratory cycle; neither pressure would fluctuate provided the RQ remained at 1 with no change in temperature or saturation in the plethysmograph-lung circuit.
3. However to produce airflow during expiration, the alveolar pressure must exceed the box pressure, conversely during inspiration the alveolar pressure must be lower than the plethysmograph (box) pressure.
4. This is due to the fact that the total amount of gas in the plethysmograph–lung circuit is constant, therefore an increasing gas pressure inside the lungs must produce a decrease in pressure in the remaining gas in the plethysmograph.
5. Therefore at any instant in time the forces of pressure in the box must be inverse to the pressure in the lung.
6. The use of very sensitive pressure transducers (manometers) mean this can be measured throughout the respiratory cycle.

* Note that this article is the author's personal view and not all devices are covered. Please email the editor at inspire@artp.org.uk if you would like to write a history of your favourite(s).

Applying this method to physical testing, they followed standard laboratory practice as today:

* The subject is seated in the enclosure and breathes the air from the closed cabin.
* The box should be vented until temperature equilibrium is reached.
* This "warming up" time can be up to two minutes and is dictated by the size of the subject; the "slighter" subject displacing a smaller volume and the remaining volume is then slow to be affected by the temperature increase caused by the subject core temperature, whilst the "larger" subject displaces a larger amount of the air in the cabin and the remaining air heats quite quickly. For the purpose of the measurement we require minimal box pressure change related to temperature increase during the time constant of the measurement.
* The subject is connected to the breathing valve with a nose-clip in place then pants in and out through the flowmeter for 5 to 15 seconds at an ideal volume of about 300 ml (0.3 litre) (this shallow panting is often described as the way a dog pants on a hot day to keep cool).
* During this breathing cycle we plot the flow on the vertical (Y) axis vs the box pressure change on the horizontal (X) axis (Figures 1a and 1b, previously Figures 2 and 3 from reference [1]).

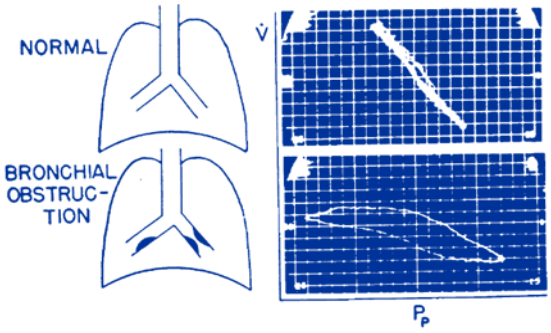


Figure 1a. Photograph of cathode ray screen (shutter open)

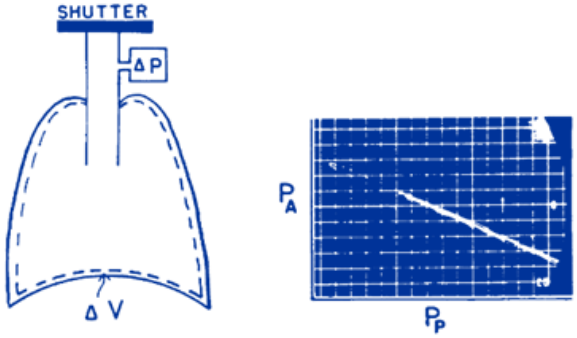


Figure 1b. Photograph of cathode ray screen (shutter closed)

It was observed that breaths of normal tidal volume would produce artefact caused by the instantaneous warming and humidifying of inspired air and the cooling and condensation produced during the expiration. This then means that the latter (expiration effect) is smaller than the former (inspired effect) and this then leads to a net increase in box pressure with each breath. More shallow breathing (panting) through the volume measuring device (and remaining within the total dead-space of the associate patient valve) reduced significantly the size of the artefact.

They also commented on the method brought to market by Erich Jaeger, which reduced this artefact if the subject breathed to and from a bag which was maintained with humidified air that mimics the conditions (37 degrees 100% Saturation) throughout the breathing cycle (Fig. 2).

This methodology was also used in Infant measurements and documented in the literature by Caroline Beardsmore and Janet Stocks[2] (Figure 3).

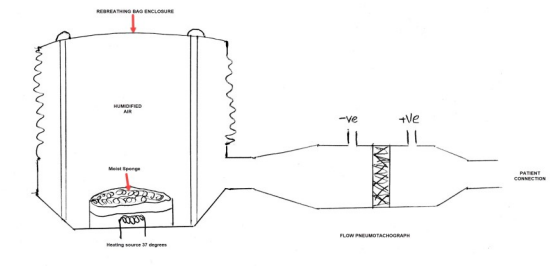


Figure 2. The 'BTPS bag', illustrated by K. Hogben

Figure 3. Infant lung function testing[2]

Previous investigators had used other methods that included normal breathing frequency and tidal volume, it was concluded that the shallow rapid breathing, such as panting, had certain theoretical and practical advantages:

a. It minimises temperature and saturation changes
b. RQ remains near constant
c. This then means these artefacts can be considered negligible

This panting method, then, improved the signal to drift characteristics as it allowed each respiratory cycle to be only a fraction of a second.

Whilst there remain gradual thermal changes and small leaks, the modern day cabin addresses this problem with the "addition" of a controlled leak. This is set at a time constant to be outside the time of measurement and therefore allows the cabin to constantly correct for temperature and pressure changes both inside and outside of the cabin.

The panting method was not without objections:

1) The volume of gas in the lungs during panting is often different from the volume at quiet breathing because the subject assumes a lung volume that reduces the sensation of obstruction to breathing.
2) The subject may open the upper airways (mouth and glottis) during the manoeuvre.
3) The subject adopts such shallow breathing that the gas distribution is not limited to the stiff regions of the lung as the gas follows the path of least resistance.
4) Panting at shallow volumes (low tidal breathing) leads to rise in PCO_2 and decrease in PO_2 during the period of the test.

Conversely, the advantages:

- It had been shown that the overall resistance of a pump running at 6 cycles per second (Hertz) did not affect the chest wall and the responses were good.
- The method adopted used a frequency of 2 cycles per second (Hertz) because this frequency fell within the operating frequency of the pressure sensors (used with a flat response through to 35 Hertz).
- The paper concluded the method to be accurate in both health and disease and it became a common measurement.

Further development to the points raised in objection 1 was to include in the airways resistance measurement an additional capture of the Thoracic Gas Volume (TGV) at which it was measured, thus allowing use of the volume corrected resistance SGaw to be the more significant variable to monitor the subject (Figure 4a, b).

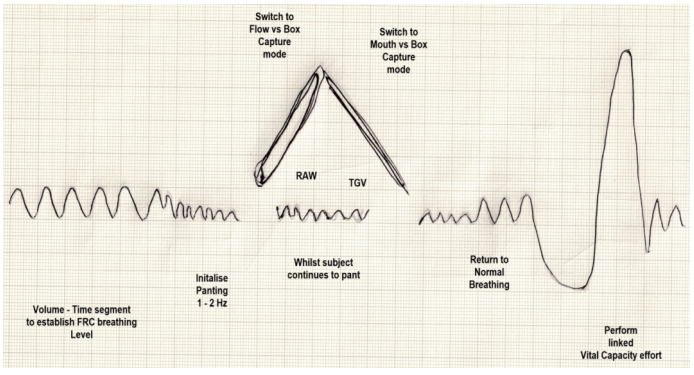


Figure 4a. Typical X-Y Plotter trace

SGaw = 1 / TGV x RAW

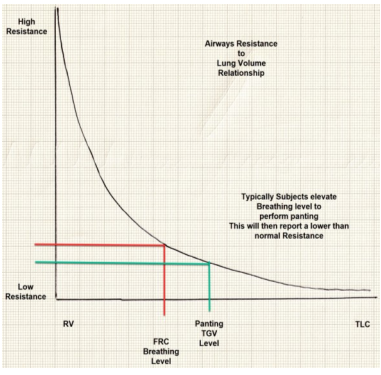


Figure 4b. Airways Resistance to Lung Volume relationship

Figure 4 images by K. Hogben

A little over 10 years later teams in Harvard University and Boston University Medical Schools, that included Peter Macklem and Jere Mead, published **'Frequency Dependence of Flow Resistance in Patients with Obstructive Lung Disease'**[3]. They used a loudspeaker to produce oscillations down the airway whilst seated in the body plethysmograph and this mixture of Forced Oscillation (FOT), lung compliance and resistance starts to show a similarity to the forced oscillation methods in use today, without the need of a plethysmograph. (Figure 5).

"DuBois, Brody, Lewis, and Burgess were the first to study the response characteristics of the respiratory system. They applied sinusoidal pressures to subjects (who suspended their own efforts to breathe) and demonstrated that the human respiratory system has a resonant frequency at about 6 cps. Since, at such a frequency, mechanical impedance is entirely flow-resistive, the ratio of pressure to flow amplitude could be used to measure the flow resistance of the respiratory system. Mead showed that this measurement could be made during breathing by superimposing the forced oscillations on the breathing pattern. Since only minimal cooperation is required, this approach is attractive for use in detecting abnormalities of flow resistance. But, does a measurement made at a frequency an order of magnitude higher apply to the conditions of ordinary breathing? In particular, does it apply in abnormal lungs? Patients with chronic obstructive disease show marked frequency dependence of pulmonary compliance, and, according to the theories advanced by Otis, McKerrow, Bartlett, Mead, McIlroy, Selverstone, and Radford, these patients should also be expected to show frequency dependence of flow resistance. To answer these questions, we measured the frequency dependence of flow resistance in a group of patients with different degrees of obstructive lung disease. We measured pulmonary flow resistance during spontaneous breathing by means of esophageal balloons, and we measured pulmonary, chest wall, and total respiratory flow resistance during forced oscillations at 3, 5, 7, and 9 cps."

Figure 5. The authors' rationale for their work[3]

They additionally compared the data with the more traditional methods, making *"… separate measurements of airway resistance during voluntary panting at a frequency of about 2 Hertz by the plethysmographic techniques of Dubois, Botelho and Comroe"*.

This was displayed on an X-Y axis. Increasing flows in the inspiratory direction produce upward deflections (and vice versa) from a zero-flow midpoint. Increasing pressures relative to atmospheric pressures produce deflections to the right (and vice versa) from a zero-pressure midpoint. When pressures are applied at frequencies below the resonant frequency of the respiratory system, pressure-flow loops are formed which develop in the clockwise direction.

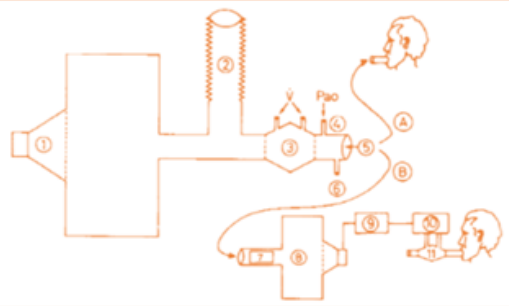
When frequencies are greater than the resonant frequency, pressure-flow loops are formed in the anticlockwise direction. As one passes from very low frequencies upward, the clockwise looping narrows and disappears as the resonant frequency is approached, to be replaced by anticlockwise looping as the resonant frequency is exceeded.

The looping reflects phase differences between pressure and flow. For clockwise looping, pressure lags behind flow. For anticlockwise looping, pressure leads flow. These phase differences result from the combined influences of the elastic and inertial properties of the respiratory system.

At low frequencies the elastic properties dominate. Elastic pressures rise during inspiration to maximally positive values at end inspiration; as a result, pressure lags flow, and clockwise looping results. At frequencies above resonance, inertial properties dominate. Inertial pressures rise at the mouth, relative to atmospheric pressures, to maximum values at the end of expiration when the inspiratory acceleration is greatest, and as a result, pressure leads flow. At the resonant frequency the lag of pressure due to elastic properties is exactly counterbalanced by the lead as a result of inertial properties; flow and pressure are in phase, and all pressure-flow looping disappears. This is what would become more familiar in the modern Forced Oscillation Technique (FOT) methods by looking at the Reactance as the product of Resistance and phase angle.

The ten year gap seems a common thread, as then in the mid 1970's several studies were published.

A Belgian group deployed the loudspeaker to create the oscillations directly down the airways as a FOT method as well as an Impulse Oscillometry method[4] (Figure 6).



1. Loudspeaker generating impulses
2. Side tubing
3. Pneumotachograph
4. Pressure measurement
5. Mouthpiece
6. Bias flow, reducing apparatus dead space.
7. Resistor
8. Large loudspeaker
9. Power amplifier
10. Transducer
11. Pneumotachograph

Bias flow not applied to setup B. Subject breathed through mouthpiece (setup A). To investigate influence of superimposing impulses on breathing, subject replaced by a constant physical system (setup B).

Figure 6 (from Landser FJ et al. J Appl Physiol. 1976)

Much of this work was being made possible by the arrival of semiconductors for basic computing functions, this would never have been possible with the oscilloscope and X-Y plotters used for the traditional body plethysmograph investigation of airways resistance.

Meanwhile, in 1981, a team at London's Guy's Hospital were also making investigations[5]. They were able to apply a micro-computer for more advanced signal processing to deal with the loop and any phase angle changes during the panting effort. Their discussion in the paper showed a better resolution of measurement, minimised sources of error and made the test quicker to perform.

The advent of the "computer" then allowed different investigators to look to quantify sources of error and improve the quality of the signal, this included the reversion to quiet breathing methods removing the need for panting. Algorithms could then be applied to address the concerns initially raised in the original DuBois paper as to temperature/humidity and pressure changes. These included "loop closing" techniques. Because the actual measurement relies on fitting a line of best fit to the loop obtained from the subject effort, the actual "loop" presents no clinical significance as, starting from a point of zero flow and zero pressure, it would be expected that the subject would return to the same condition of zero flow and zero pressure at the end of a single excursion for any cycle. Therefore the "open loop" is a result of the artefacts of the measurement and can be digitally or electronically compensated for to arrive at the pure slope of inspired and expired resistance pathways.

In 1983 the ECCS guidelines[6] described the then most common method to derive the resistance as a function of the slope of the line fit to the curve from zero flow to 0.5 Litres on the inspiratory and expiratory side of the loop in both Closed and Open loop methods (Figure 7). *"Resistance is usually measured between 0 and 0.5 L/s dots, but may also be obtained from the extremities of the loop (total resistance)".*

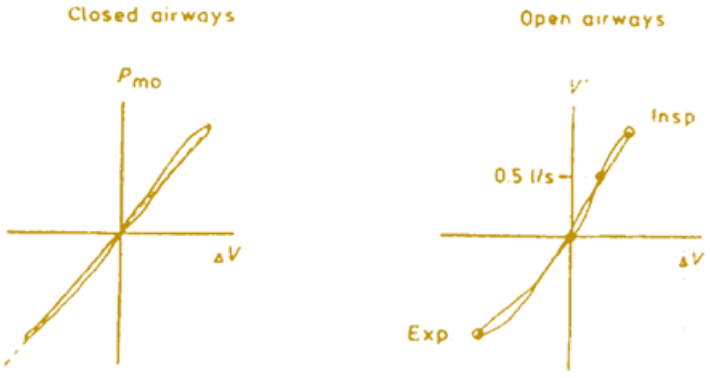


Figure 7. Closed and open airways. From Quanjer PH. Respir. 1983;19(Suppl 5)

There are many suggested methods of airway resistance loop analysis. In Germany, Matthys and Ulmer were widely published. Matthys suggested the fully combined study in a body plethysmograph[7] (Figure 8).

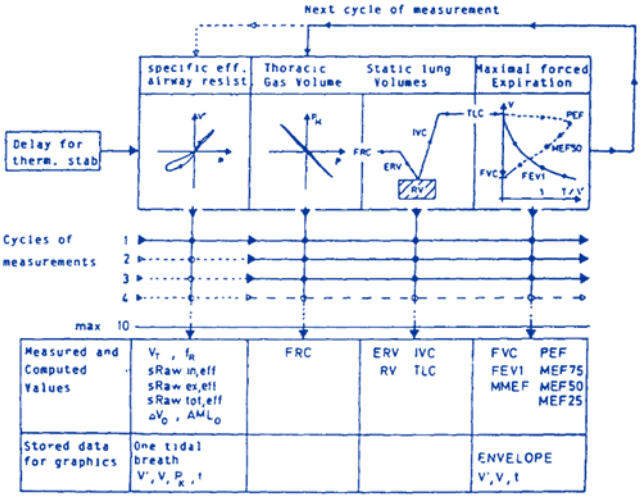


Figure 8. Measurement procedure of whole body plethysmograph. From Zaiss AW, Matthys H. Lung. 1990;168 Suppl:1185-92

While Ulmer published work investigating the disease state of a subject, the complexity of the curve and the ability to make simple line fits[8]. Their work displayed the "classic hammer head" loop of a severely ill subject (Figure 9a, b, from Ulmer WT, Reif E. Dtsch Med Wochenschr. 1965 Oct 8;90(41):1803-9).

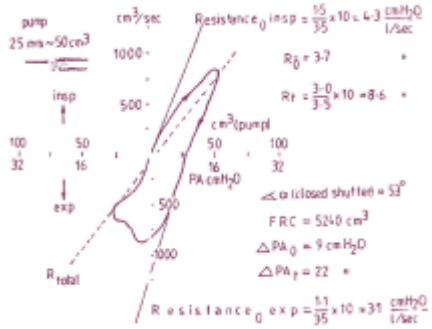


Figure 9a: The course of the flow resistance curve in patients with obstructive airways disease with disturbances of the ventilatory distribution. (ROI=inspiratory flow resistance at zero flow, ROE=expiratory flow resistance at zero flow, RO= (ROI+ROE)/2, RT=total resistance)

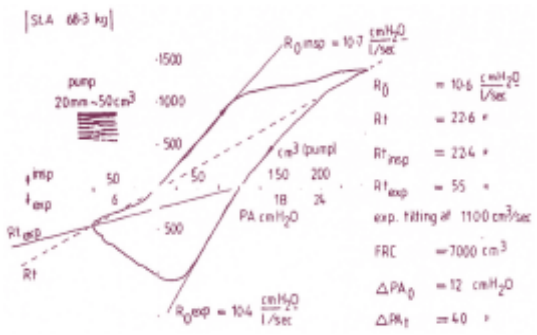


Figure 9b: Flow, plethysmographic curve for the case of a severely ill patient with chronic obstructive airways disease (total resistance=22.6cmH2O/(l/sec), breath synchronous alveolar pressure difference=40cmH2O)

The Ulmer paper concluded:

"The obstruction of the airways represents a central occurrence in the case of most diseases of the lung and airways. Whole body plethysmography allows considerate, rapid and reliable measurement of the functional residual capacity and the flow resistance in the airways. The method described is restricted to those data that are of importance to the practice. A few typical changes during the course of the curve, in the case of larger airway resistances, are discussed. The recording of spontaneous breathing supplies a series of results which reveal a dynamic picture of the flow conditions during inspiration and expiration. Because of the good reproducibility and because of the almost unlimited ability to repeat the measurements, the method also makes possible the reliable assessment of drugs affecting the bronchial system".

Measurement of airways resistance using a body plethysmograph is not new, but a well established measurement also leading to FOT, creating new interest today. As Ulmer stated, it is a rapid, reliable method of assessment of drugs affecting the bronchial system. Airways resistance is a sensitive measurement of change in airway response requiring good co-operation from the subject for successful results. We have also seen how Pressure/Temperature and humidity plus the ability to maintain a breathing frequency may impact on the results obtained. FOT methods use Fourier transforms to separate the basic harmonic of tidal breathing from the resonant frequency pulsed down the airway and the phase angle shift to the returning signal all focus on the same analysis, airway calibre, by measuring the resistive component they offer to breathing.

It proves the thoughts of DuBois and others in the 1950's, using comparatively primitive observation tools, were correct. Applying today's technologies we can continue to develop our understanding of the bronchial tree. Understanding that the quiet breathing pattern may be more normal for airway calibre and that panting may falsely shift the lung volume at which we measure. Perhaps breathing in a tidal pattern allowing the device to pant for you may bring together all the benefits without complication. We still have much more to learn about Airway resistance and its science.

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Edited by

Dr. James Stockley

ARTP Chair of Research and Innovation

FRESH AIR

Dear Reader,

Welcome back to 'Fresh Air'. These articles are designed to communicate novel trends in research, innovation and clinical practice from both respiratory and sleep sciences. Our aim is to provoke thought and conversation within the ARTP community that we hope will benefit the future direction of physiological practice.

For this issue of Inspire, we are fortunate to have a contribution from an external author. Dr Hejie He is a Cardiology Research Fellow at University Hospitals Coventry and Warwickshire NHS Trust and has kindly provided an article exploring the relationship between obstructive sleep apnoea and cardiac arrhythmia, together with some pilot data from his ongoing study

James Stockley
ARTP Chair of Research and Innovation

Introduction

Obstructive Sleep Apnoea (OSA) is estimated to affect 4-8% or around 1.5 million 30–69 year-olds in the UK[1]. OSA has a significant overlap with cardiovascular disease, both directly and indirectly. It shares predisposing factors (such as obesity, male sex, older age, smoking and alcohol) and can contribute to cardiovascular disease by increasing blood pressure and increasing stress and tiredness, which has been extensively summarised by Somers et al.[2]. More specifically, the physiological sequelae of OSA on thoracic pressures, hypoxia and oxidative stress have been shown to increase cardiac arrhythmia risk, bradycardias in the short term and tachyarrhythmias in the longer term[3]. This increases the risk of sudden cardiac death, stroke from atrial fibrillation (AF) and heart failure. Significantly, the Sleep Apnoea Cardiovascular Endpoints study (SAVE) showed that CPAP did not significantly reduce risk of significant cardiovascular disease[4]. Despite this, routine care of OSA in the UK does not include screening for arrhythmias such as AF. This article explores the mechanisms that link OSA and arrhythmia and details the OSCA study which will determine the true incidence of AF and other arrhythmias and evaluate the most significant mechanisms linking the diseases.

Mechanisms

The cardiac autonomic nervous system is a key way in which the body maintains homeostasis of the heart and lungs. The sympathetic nervous system '*fight or flight*' response and the parasympathetic nervous system '*rest and digest*' responses are antagonistic and imbalances or hyperactivity in both are linked to tachyarrhythmias, particularly AF and ventricular tachycardia (VT). Abnormalities in breathing, especially apnoeic episodes, significantly elevate sympathetic activity and parasympathetic activity. Pauses in breathing trigger parasympathetic activity via baroreceptors in the lung and cause paroxysmal bradycardias. This can reduce the atrial effective refractory period and promote increased activity in atrial myocytes in the pulmonary vein ostia, leading to AF. Studies in sleep apnoea patients show that their sympathetic activation is higher throughout the day and not just during sleep[5]. Increased sympathetic tone can also induce ectopy and increased firing in atrial tissue in the pulmonary veins, again leading to AF. Parasympathetic and sympathetic activity can be measured using spectral analysis of heart rate variability (HRV) from 24-hour Holter recordings. Cycles of HRV are observed and grouped into ultra-low, very-low, low and high frequency bands. Loss of variability indicates higher risk of cardiovascular disease and arrhythmia. Analysis and comparison of HRV before CPAP initiation and at a time after treatment will demonstrate any significant changes to cardiac autonomic control over this time. This can be correlated to arrhythmias identified by an implantable loop recorder (ILR). Heart rate turbulence (HRT) will also be derived from Holter data and analysed in the same way as HRV.

Mechanisms linking sleep apnoea and major adverse cardiovascular events (MACE) include oxidative stress, endothelial dysfunction, mechanical stress and inflammation during hypoxic episodes in sleep apnoea. The most researched markers associated with sleep apnoea were high sensitivity C-Reactive Protein (hs-CRP), tumour necrosis factor-alpha (TNF-α) and interleukin-6 (IL-

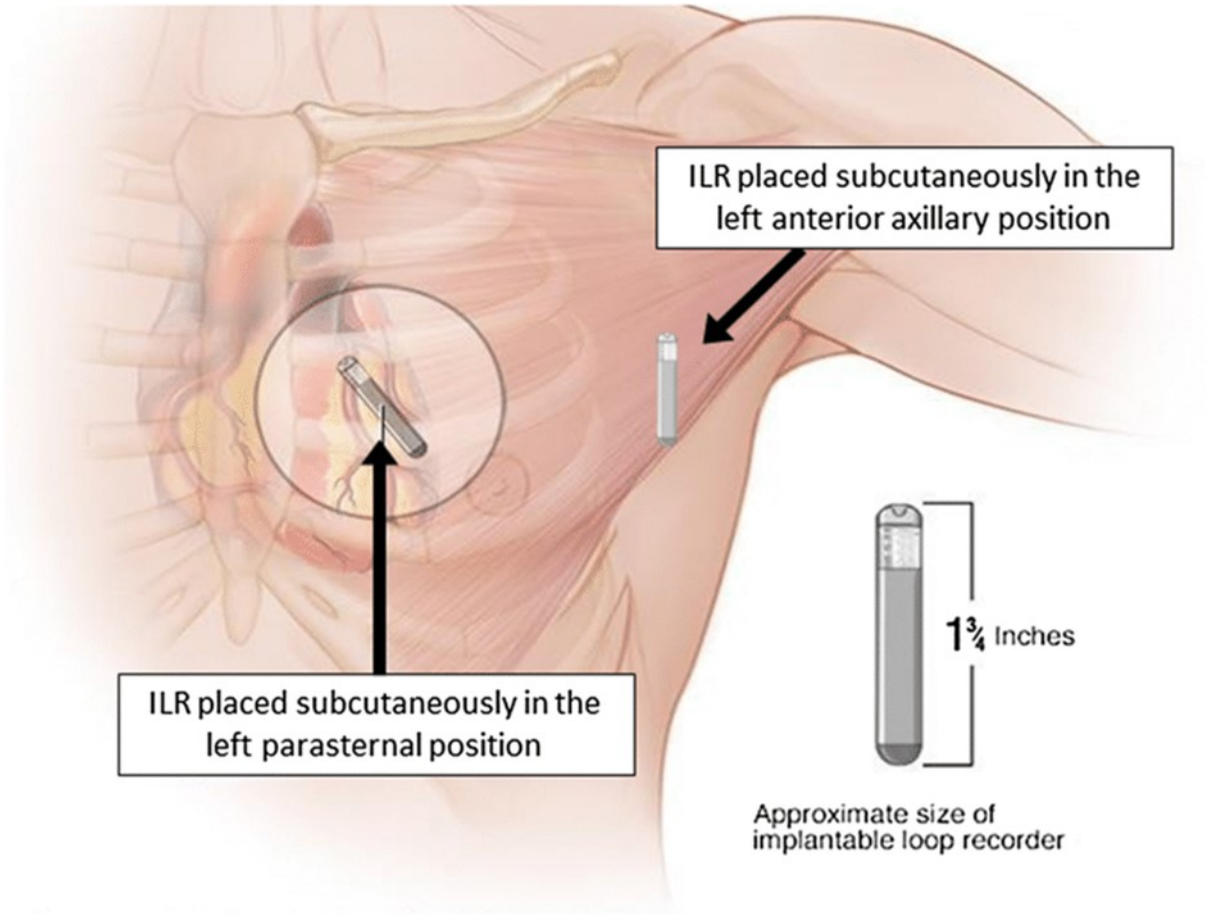

Figure 1: ILR Size and Placement: From Anderson H, Dearani J et al. Pediatric Cardiology (2020) 41:181–185 https://www.researchgate.net/figure/Implantable-loop-recorder-ILR-in-the-left-parasternal-and-left-anterior-axillary_fig1_337370088.

6). These all look at levels of inflammation in the body. A 2013 meta-analysis shows C-Reactive Protein (CRP), TNF-α and IL-6 reduce with CPAP treatment in patients with moderate to severe sleep apnoea[6]. However, all the studies involving TNF-α and IL-6 cited had low numbers of patients and further study with larger numbers is warranted. Other studies revealed matrix metalloproteinase-9 (MMP-9) is a useful marker in identifying hypertension in sleep apnoea patients[7]. It is associated with oxidative stress and, therefore, cardiovascular damage and has been shown to be increased in hypoxia. Increased levels of MMP-9 have been correlated with increasing severity of sleep apnoea. High sensitivity Troponin-T (hsTnT) is a heart specific enzyme which is released upon damage to the heart. N-terminal pro B-Type Natriuretic Peptide (NTproBNP) is a precursor to Brain Natriuretic Peptide (BNP) and is released from the walls of the heart in increased tension. Both are useful diagnostic and risk stratifying markers for ischaemia and heart failure, respectively, though there may be some overlap. HsTnT is also linked with increased incidence of AF. In a recent study, Fibroblast Growth Factor 23 (FGF-23) and NTproBNP has been shown to correlate with the development of AF in the general population[8].This marker may be an important link between sleep apnoea and AF. A better understanding of the arrhythmia profile, CPAP usage, autonomic dysfunction profile and biomarker profile may help identify what drives the cardiovascular mortality and morbidity in sleep apnoea patients and help target treatment.

Whilst Continuous Positive Airways Pressure (CPAP) does reverse these physiological processes and has been shown to reduce symptoms of sleep apnoea and quality of life, the largest randomised OSA and CPAP study with over 2,500 participants (SAVE) demonstrated no meaningful reduction in AF or MACE despite CPAP therapy[4]. Additionally, a small study using an implantable loop recorder demonstrated a 20% incidence of AF in 25 sleep apnoea patients undergoing CPAP therapy[9].

Obstructive Sleep Apnoea and Cardiac Arrhythmias (OSCA) is a prospective observational trial using implantable loop recorders to determine the overall incidence of atrial fibrillation and other arrhythmias in a CPAP-treated moderate-severe OSA cohort and use Holter monitors to identify potential understudied mechanisms linking OSA to Arrhythmia.

Methods

The Obstructive Sleep Apnoea and Cardiac Arrhythmia (OSCA) trial is a prospective multi-hospital randomised controlled study. Participants are being recruited from sleep clinic after diagnosis of OSA and prior to CPAP initiation. All participants continue their usual treatment pathway for OSA alongside the trial protocol. A randomisation process occurs at consent, with a 1:1 split with one group receiving an ILR, 24-hour Holter, echocardiogram and blood tests, and the other receiving remote follow-up only; this follow-up is repeated in both groups at 12 months and 3 years remotely. The burden of arrhythmia in each group will be compared, with a focus on AF as defined by national and international guidelines[10, 11]. Identification of arrhythmia and treatment is implemented by the principal investigators and guided by the Trial Steering Committee. The arrhythmia profile of those in the ILR group will be correlated to cardiac autonomic function parameters (both HRV and HRT), CPAP usage, echocardiogram findings and vascular biomarker profiles. MACE outcomes will be compared between the groups. The OSCA trial started recruiting in October 2019 with an 18 month recruitment period and follow-up of 3 years. However, recruitment was halted very soon after due to the Covid-19 pandemic. Recruitment for the trial restarted in April 2021 and is to complete in March 2022.

Objectives

The primary objectives are to characterise the arrhythmia incidence/burden in an OSA population using ILRs compared with standard care alone (the primary endpoint being clinically significant arrhythmias [for which we would treat]) and to assess cardiac autonomic function at baseline and following 12-months of CPAP therapy in the ILR group. The secondary objectives are to: a) compare morbidity (with focus on MACE outcomes) of patients with OSA in both groups, b) explore frequency and onset of arrhythmias in the ILR-group vs no ILR-group with respect to CPAP usage profile, c) identify predictors for arrhythmia from all data gathered (including demographics, medical history and measured parameters as above), d) characterise general cardiovascular and inflammatory biomarkers at initiation and during CPAP in the ILR group, e) explore OSA patients in terms of patient reported outcome measures in the ILR group.

Preliminary Results

We have recruited 200 OSA patients with 100 ILR and 100 No ILR. The average follow-up period to date is 8 months. The average AHI at baseline was 43.9. We are only demonstrating basic demographics and arrhythmia detection to date. Further data gathering and analysis will be available in due course.

	ILR (n=100)	No-ILR (n=100)
Demographics mean or frequency (%)		
Age	54	52
Female Sex	30 (30%)	31 (31%)
Arrhythmias		
AF	6 (6%)	0
Pauses	3 (3%)	0
Sinus Arrhythmia	2 (2%)	0

Preliminary Conclusion

There is a higher incidence of atrial fibrillation than published data after only an average of 7 months follow-up despite CPAP usage.

Discussion

We have already demonstrated a higher incidence of AF in this cohort of moderate-severe OSA patients despite only 8 months of follow-up. Analysis of significant confounding factors such as co-morbidity, CPAP usage statistics is due to follow. Preliminary HRV and HRT analysis, cardiovascular and inflammatory biomarkers will be completed once recruitment has finished.

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My Professional Journey

Hayley Capewell
Senior Respiratory Physiologist, University Hospitals of Derby and Burton NHS Foundation Trust

My professional journey to becoming a Respiratory and Sleep Physiologist did not just begin when I applied for a place on the new apprenticeship degree in Healthcare Science (Cardiovascular, Respiratory and Sleep)* which was being run in partnership with the Sheffield Hallam University and University Hospitals of Derby and Burton (UHDB) in 2017.

Where I am today has been a journey that has allowed me to explore a variety of roles, which have not only given me the essential skills and experiences necessary for the treatment and care of patients, but has also given me the pleasure of working alongside some amazing and incredible people.

Most individuals within the field of Respiratory and Sleep Science have typically come into the industry via a full-time science-related degree, quite early on in their life, and are established in their career pathway by the age of 30 years old. For me, my pathway has been a little less conventional, when at 30 years of age I left the hotel & leisure industry and joined the NHS.

I started out working part-time (maternity cover) as a qualified Cardiac Exercise Instructor, teaching patients both Phase III & Phase IV, endorsed by the British Association for Cardiovascular prevention and rehabilitation (BACPR). This role gave me insight into some very complex cardiac conditions, as well as other chronic medical conditions, medical jargon and more importantly it opened my eyes to the variety of jobs that are available within a hospital setting.

A key part of this role was having to understand clinical reports and outcomes of diagnostic tests including ECG's, Echocardiography, lung function, oxygen saturation etc., in order to prescribe safe and effective physical activities and exercise programs. It also made me want to know more about other jobs, their particular skill sets and how to get into the world of diagnostic testing.

* Editor's note: find out more about apprenticeships here: https://www.skillsforhcs.com/apprenticeships

So in 2010 I applied, and was successful, for a part-time Assistant Clinical Physiologist position. Working part-time enabled me to continue with my exercise instructor role. With guidance and training from within the Clinical Measurement Department (CMD) at UHDB, I became competent in ECGs and cardiac monitoring. Over the years I progressed, and developed my skills further to aid senior colleagues within other areas including nuclear cardiac stress testing, gastric and urodynamic tests.

In 2013 I decided to leave the exercise instructor role and was successful in gaining a role as a full-time Senior Assistant Clinical Physiologist. It was at about this point where I started to immerse myself into the world of respiratory, with the start of my Spirometry training, which would lead me on to obtaining my ARTP Spirometry Accreditation. Over the next few years I became established in my job, also enhancing my teaching skills and assisting in the training of others, from medical students for their OSCEs to practice nurses for their ARTP spirometry qualification.

After 6 years within the department, despite loving my job, I wanted a little more. I wanted to be a physiologist, not just an assistant, but at the time I felt a little stuck as how to attain this. There were some in-house 'grow your own' programmes, but I didn't quite fit the qualification criteria, nor were the alternative routes in the NHS Pathways such as the Practitioner Training Programme (PTP) an option for me. Leaving my job and going to university wasn't a logistically or financially viable option at this point in my life. Realising that I was between a rock and a hard place, I was starting to become rather disappointed with myself, disheartened with my work and tinged with frustration. Year-on-year I was training up individuals with the diagnostic know how and interpersonal skills to develop them for the jobs, which at the time seemed unattainable to me.

Then, within 1 year my life was turned around. I took a decision to update some older qualifications, hoping that this would make me more appealing in the future for other jobs or opportunities. A few months later I was informed, by a senior colleague within my department, of a new apprenticeship scheme to aid 'unqualified' staff into becoming qualified in order to adapt and enhance the skills of the current work force. This meant that I could stay within my current work place, getting a recognised degree, and hopefully progress in my career.

Well here I am today! A Senior Respiratory Physiologist. Don't get me wrong, it was no plain sailing, trying to juggle a full-time job with some sort of home and social life, whilst studying for a full time degree, learning new skills, completing competencies, assignments and studying for exams and completing the ARTP Practitioner's qualification (oh, and a global pandemic mixed in!)…but as you can see, it can be done.

I am no grade A* student! I wish I could just look at a book and absorb it; unfortunately my brain isn't wired that way. But, I graduated with a 2:1 and passed the apprenticeship part of the degree with a distinction.

This wouldn't have been possible without a little self-sacrifice on my part, with late nights and long weekends studying in the library, along with the support of my family. Also, with the guidance from the team at Sheffield Hallam University, the help of my managers and fellow colleagues at the CMD, but most of all, a huge thank you for the assistance, advice and encouragement of my fellow respiratory team; my work family. The biggest shout-out to my amazing supervisor and mentor, Julie McWilliam. She, who is a fountain of all knowledge, a respiratory oracle and a guru of all that is sleep, here at Derby. There is no amount of thanks or accolades great enough that I could fit on this page to her for having the belief and faith in me (as well as the patience of a saint!). Without her teaching and daily guidance none of this would have been possible and I wouldn't be where I am today.

A Respiratory Physiologist!

So, to all heads of departments, don't overlook your current staff, there is probably someone with burning ambition and drive, as well as the knowledge and experience but who just doesn't quite fit with the standard criteria. Give them a helping hand, point them in the right direction, give them the support and guidance necessary, and you may just change their world.

Dr Harry Griffin (PhD)

Lead Respiratory Physiologist

Hampshire Hospitals NHS Foundation Trust

Top Forum

The best of the ARTP Forum

Summarising the most popular topics in the ARTP forum since August Inspire.

Title: Hypoxic challenge test NHS or Private?

Date: 17 November 2021

Question: I've gone ahead and taken the liberty of changing the title here from 'fitness to fly' to hypoxic challenge test (HCT) because we need to move away from using this inaccurate term.

The physiologist posting on the forum had recently been told by more than one patient that HCTs were no longer available on the NHS and they would need to find a private service provider. The physiologist was unsure if this was due to COVID restrictions or just a patient misunderstanding.

Replies: The first reply discussed that in their experience provision of HCTs on the NHS or Privately differed between trusts and that they didn't think COVID had made any impact on these decisions.

Having undertaken a survey of NHS hospitals in the UK in 2018 along with Lead Physiologist Helen Purcell, we found that of the 59 departments that responded and performed HCT's, 33.9 % (20) performed HCTs on the NHS, 11.9 % (7) privately and 54.2 % (32) performed HCT both privately and on the NHS.

There was a word of warning from a very experienced respiratory physiologist who replied stating *"under the NHS contract, health care professionals are not allowed by NHS England to give advice on suppliers outside the UK (i.e. they cannot recommend a company to a patient if they ask)."*

Title: Recommended room sizes

Date: 22 November 2021

Question: The physiologist discussed that they had started planning for a new department with future proofing up to 2035. They wanted to know if there was any guidance or recommendation on room sizes for the various respiratory tests.

Replies: A previous ARTP chair and another physiologist both highlighted a useful resource that they felt was excellently constructed by Martyn Bucknall. They did however mention it could probably do with an update and/or review as it was published in 2006.

ARTP Working Groups on Standards of Care and Recommendations for Lung Function Departments (2006). LUNG FUNCTION DEPARTMENT SIZE AND SPACE RECOMMENDATIONS

Furthermore, they inserted a link to another useful resource, although not lung function specific

https://www.england.nhs.uk/publication/designing-health-and-community-care-buildings-hbn-00-01/

Finally, the physiologist also suggested the Health and safety at work regulations (regs 10) also have room size within it https://www.hse.gov.uk/contact/faqs/roomspace.htm

Title: CPAP data

Date: 01 December 2021

Question: A senior sleep physiologist raised a concern they had been having with CPAP compliance data. They wanted to know if others had seen the same thing and what could be done to resolve it. The tabular data showed the CPAP machine turning on and off very frequently. Despite first thinking it was due to poor mask fit and the smart start (auto start and auto stop) activating it still occurred when this setting was switched off and also in patients without a mask leak. The manufacturer of the CPAP device was relatively new to their service.

Replies: This triggered a senior physiologist to reminisce over observing thousands of sleep study videos and how it never failed to amuse them that after watching the patient sit up and remove their mask, blink at the camera and go back to sleep that the patient would swear blind it never happened! Nevertheless, they accepted that as scientists we should investigate these issues and they suggested a number of steps to take: Is it in the same patients?, Is it repeatable on the same device?, How old is the CPAP device?, Is there a reliable power source? (Faulty plug, arcing mains. etc.)

Another physiologist stated they had also recently started using this make of CPAP machine and had seen a similar pattern on a patient on nights when their mask hadn't leaked. Several other physiologists suggested you should look at the more detailed data that you might only get with a manual download to ensure it isn't associated with a high leak.

A senior physiologist and member of the ARTP council stated that ARTP SAC would try and investigate this issue by reviewing the CPAP machine test data performed in Germany a few years ago. However, this would depend on whether this particular model has been tested.

Title: Floor mopping

Date: 17 December 2021

Question: There are many fewer COVID posts now but we couldn't do a Top Forum without at least including a couple. In this first one, the physiologist discussed that their IPC team were reviewing procedures and were now requesting that floors were mopped between every patient. The physiologist wanted to know if this was something other Trusts are being asked to do.

Replies: Numerous replies all stated that they were only having the floor mopped at the end of the day. Indeed, two physiologists highlighted that the risk of slipping was probably greater than the minimal risk of catching COVID off the floor, as long as you encouraged patients not to lick it!

Title: Quick Question

Date: 29 December 2021

Question: The second COVID post was about our regular discussion on fallow times……and therefore we all knew this 'quick question' was never going to give 'quick answers'. The physiologist asked if departments were back to business as usual or whether they were still routinely allowing for fallow time or were they being pressurised to drop the fallow time?

Replies: One reply stated they were using HEPA air scrubber systems to augment existing room ventilation, achieving an equivalent of 20 ACH and had thus reduced fallow times to a maximum of 15 minutes. Several other physiologists stated they were still implementing fallow times and would continue to use them for the foreseeable future. However, one physiologist stated they had high levels of ventilation and thus had dropped fallow time for all but bronchial challenge and CPETs. For high-risk patients (i.e. immunosuppression,

transplants etc) they kept the fallow time and did these only at one site.

As seems to have been the case throughout this pandemic, asking a question regarding ventilation and fallow times provided useful answers from the physiology community but also raised more questions. Indeed, this thread prompted further questions including: Have departments using HEPA gone for systems that included UVC or those without? Is anyone using lateral flow testing as a formal approach to reduce the risk and has anyone adopted a change in risk mitigation based on patient vaccination status?

Title: Sustainable use of MDI during PFT testing

Date: 27 January 2022

Question: This physiologist discussed how they were exploring sustainable testing and in particular ways to minimise wastage in BDR testing. They were considering reusing Salbutamol canisters and wanted to know if other departments did this?

Replies: The first physiologist to reply stated they had previously had a lot of negotiation with IPC and medicines management regarding this. It was eventually agreed that they could just wipe down the MDI between each patient and disinfect the spacers with Milton solution. However, they suggested since COVID they didn't think they would have as much luck with IPC teams.

This led a previous chair of ARTP to suggest you can't be too careful and he highlighted that he wore a mask, visor gloves and a plastic gown reading the Forum and was pleased to report he was infection-free. He did however, suggest common sense needed to be returned to IPC measures in order to balance against sustainability.

Title: Risks of arterial blood gases.

Date: 01 February 2022

Question: As we know, the forum is predominately used to ask the physiology community for advice but it is of course an excellent tool to share key information. Indeed, a previous chair of ARTP highlighted a recent publication in ERJ Open Research that discussed the risks of arterial blood gases.

Rowling SC, Fløjstrup M, Henriksen DP, et al. Arterial Blood Gas Analysis: as safe as we think? A multicentre historical cohort study. ERJ Open Res 2022; in press (https://doi.org/10.1183/23120541.00535-2021).

Replies: This prompted another physiologist to highlight that it was very common in their service to have patients discuss their [negative] experiences of arterial blood sampling when done on the ward. They felt it was very important to be competent in performing arterial blood sampling, being aware of the risks and being able to communicate these to the patients.

Title: K_{CO} and 'correction for lung volumes'

Date: 16 February 2022

Question: Probably a little sad but whenever I see anyone post about K_{CO} and discussing whether its just TL_{CO} divided by V_A I can't help but picture the steam coming out of the ears of some of the more 'senior' physiologists. I then picture them saying "just breathe", making a cup of tea, sitting down in front of their typewriter and after letting out a long sigh, proceeding to bash out a reply.

In defence of the physiologist posting about this, they weren't actually implying they thought K_{CO} was just TLco corrected for lung volumes. Indeed, they started by saying:

"It's clearly an oversimplification of the measurement and the underlying physiology it reflects… but equally, does the phrase lie somewhere between the realms of:

1. Not providing any interpretation at all and assuming the person reading the PFT report is able to understand the intricacies of K_{CO} themselves (not always a safe assumption).

2. Unnecessarily overcomplicating a report and creating potential for errors or misinterpretation/over diagnosing"

The physiologist wanted advice on what to suggest for medical colleagues when interpreting their results in clinic letters.

Replies: Lets begin with a lengthy reply from one of our top respiratory physiologists who happened to reply first. They, and indeed several other well-known physiologists later posted to highlight that the Kco is not TLco corrected by V_A. In contrast, the Kco is measured during the test as shown by the equation where the $\log_{10}$ term in [x] multiplied by 53.6 and divided by Breathhold Time (BHT). You can then estimate the lung volume accessible during the 10s BHT, known as the V_A and together they produce the TLco.

This well respected physiologist isn't beyond giving credit to others and highlighted the teachings from Mike Hughes and John Gibson who state you should first interpret the Kco and V_A and then move onto the TLco. To add a little personal touch the physiologist discussed how African middle distance runners have a raised Kco. This was due to this population having smaller lung volumes (i.e. lower V_A) but the same pulmonary capillary blood volume and thus a greater uptake of CO per unit of lung volume.

Another physiologist who was a fan of Mike Hughes posted the below link to a very useful resource on gas transfer which goes into further detail. Indeed, they believed it had a very concise summary and a useful algorithm for interpretation.

https://breathe.ersjournals.com/content/breathe/15/1/69.full.pdf

There was an interesting reply that may or may not have been meant to be sent off-forum! This was from an author of a published paper on this topic with John Cotes. They stated it "*stirred up a hornet's nest of controversy on the subject*" and it might be interesting to read the correspondence pages of the journal following the appearance of our paper where Mike Hughes et al challenged us and John Cotes replied to his comments.

https://erj.ersjournals.com/panels_ajax_tab/jnl_ers_tab_pdf/node:60261/1

ARTP Association for Respiratory Technology & Physiology

ARTP Annual Conference 2022

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Please be advised that ARTP would like you to join them on the **5th May 2022 at 3.30pm** for the Annual General Meeting**.** The AGM is taking place as part of the ARTP Conference 2022, being held at the Jury's Inn Hinckley Island Hotel.

If you are unable to attend and would like someone else to attend in your place, please email **admin@artp.org.uk** at least 48 hours before the AGM takes place.

An agenda for the AGM will be shared in due course and we look forward to seeing you at the AGM.

ARTP Association for Respiratory Technology & Physiology

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Northern Ireland

East of England

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As a Regional Lead, you will be responsible for facilitating Regional Network Meetings (a minimum of 2 per year) and will feedback any topics discussed and matters of interest to the ARTP Network Co-ordinator. The purpose of these meetings is to promote discussion on regional and national matters and offer an opportunity to share departmental practices and information such as SOPS, policies, audits and research. Questions and problems raised during these meetings can also be cascaded to the ARTP Executive board for advice and resolution, if needed.

ARTP would also like to hear from members who would be interested in attending Regional Network Meetings.

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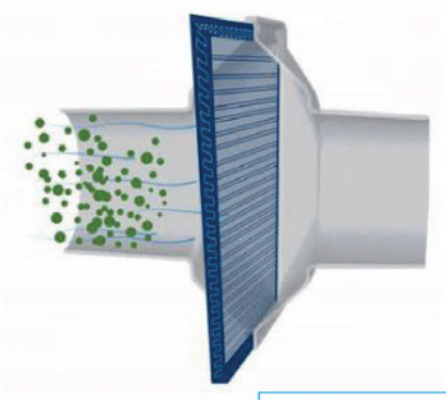

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