April 2018 VOLUME 19, ISSUE 1

ARTP
Association for Respiratory Technology & Physiology

Inspire

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FIRST WORD

ARTP REGIONAL NEWS

Welcome to the 'conference special' issue of **Inspire**. Where do we rate the recent Brighton conference alongside those previously? Pretty highly I would say— in the quality and volume of submitted abstracts (the highest ever received apparently), the presenters, the venue, the entertainment and the superb organisation which made it all run seamlessly. I learned, amongst other things, that people call them dodgems, or bumper cars, and drive them accordingly, that Brighton is a great place to visit from London (but not to get back from by public transport on a weekend) and that Professor Bush is a "top bloke". 2019 is already planned! This issue, then, contains all of the abstracts from conference. There is a timely article about promoting Physiologists to produce research (strange as it may sound) and this is one of three from authors who were awarded ARTP bursaries to attend the conference. Bursaries for this and other conferences are available to ARTP members on the website. Space did not permit all winners to be published in this issue but space **will** be found in the August issue!

Inspire takes time to prepare and this does not lend itself to being as 'current' as social media is, for example. We shall try to round-up items of interest between issues in "Fresh air" and I am grateful to Suhilla for compiling this. I am sure that Matt will not mind my saying he has put together a fantastic summary of the conference manufacturer stands, in OTB.

Thanks as usual are due to the Editorial team, whose proof-reading skills often astound me. Thank you also to the contributors. I am keen to present more about the ARTP regional groups and for a start, see the Regional News page. If you feel you have anything that may be of interest for that or anything else then please get in touch with me by email at inspire@artp.org.uk. See you in August.

As we went to press, we learned of the sad passing of one of the greats of Lung Function, Dr. J.E. Cotes. It is fair to say that anyone who has worked in a lung function laboratory will be aware of his *'Lung Function'* textbook, which has been indispensable since its introduction in the 1960s. Further tributes are contained in this issue and I shall let this photograph of one of our laboratory copies (4th Edition—"my" version) stand as mine.

Aidan Laverty

A WORD FROM THE CHAIR

Dr. Karl Sylvester

ARTP Honorary Chair

Welcome to your post-conference bumper edition of Inspire. Lots to read this edition, including the abstracts of the research presented in Brighton as well as all the manufacturer updates. There are a few fabulous photos thrown in too. Hopefully this will whet the appetite for those thinking of attending in 2019.

We had a record breaking number of abstracts presented this year with wide varying themes and all of an exceptional standard. It was fantastic to see so many delegates attending, heavily involved in research within their departments, identifying areas of innovation and developing their services for the benefit of patients and the public. I hope we can break the record again for the next conference, so start thinking of presenting the research you may be currently undertaking or how you are developing innovative practice within your organisation.

One area I feel we could do better is letting people know how good we are and how brilliant the services are that we provide to our patients. Whether that be at a local level within organisations or at a national level. One way to get the message out is through presentations at events such as ARTP but also at wider events such as the British Thoracic Society or European Society congresses, where a wider representation of the healthcare workforce attends. Those of you that have already presented at an ARTP conference will know what a friendly audience we are and this is the perfect place to get the practice in for presenting at one of the national and international conferences.

As well as research presentations there were excellent invited speakers updating on breathless patients and how to help them, current hot topics in paediatrics, looking forward with innovative equipment and utilising current technology differently and best practice in non-invasive ventilation. Our keynote speakers were again of top quality, including Prof Peter Calverley, Dr Tim Quinnell and Dr Mike Stroud,

the latter detailing his many fascinating years taking part in extreme challenges with the impact this had on his body. It's going to be a hard act to follow but we will do our best.

I'm delighted that the ARTP Events team https://twitter.com/ARTP_events are taking us to Glasgow in 2019 and preparations are well underway to raise the bar yet again. If you have any suggestions for what you'd like to see on the programme then please do let me know. Additionally, if there is anyone that you feel should be recognised for their outstanding contribution to respiratory physiology and medicine, be it a physiologist, scientist, medic, physiotherapist, nurse etc, then please do nominate them. We have had some top class winners in previous years and as mentioned before, let's shout about what we do that is great and get nominating.

Conference 2019 will be a bitter sweet event for me personally as it will be my last as ARTP Chair, but more of that nearer the time.

Enjoy the read!

IN MEMORIAM

Dr John E Cotes

DM, DSC, FRCP, FFOM, Dhc

1924-2018

We were all saddened to hear of the passing of one of the forefathers of modern respiratory and sleep physiology. Dr John Cotes gave so much to our profession to advance our understanding of physiology and how it can be measured effectively and accurately.

There has never been a better resource published for our profession than "***Lung Function: Physiology, Measurement and Application***", now in its sixth edition with a possible seventh on the way. This will forever be known as "The Bible" in many a lung function laboratory across the country. There are many within ARTP that will have been trained by John, have cited his many publications and will use equipment that John was instrumental in developing. John's passing is a huge loss and creates a void that will never be filled.

Our thoughts and prayers are with his family at this sad time.

Dr Karl Sylvester /Honorary Chair ARTP

ARTP Association for Respiratory Technology & Physiology

I was saddened to hear of the death of John Cotes on Sunday night, particularly because he was a person who had probably shaped my career (and the lives of nearly everyone who works in UK lung function services) far more than I/we had ever realised.

Many of us can remember having "Cotes" - the book - thrust at us on our first day in the lung function lab and told to "Read that!". The evolution of the lung, testing equipment developments, reference nomograms and the most eclectic referencing system of any textbook ever, became, as many have stated "the bible" of the lung function laboratory. It was a theoretical "manual" and practical handbook that complimented Julius Comroe's "The Lung". How many labs around the world were shaped by John's attention to detail?

When I began my career at the Freeman Hospital, Newcastle upon Tyne, there was an undercurrent of rivalry between John Cotes at the RVI/University and John Gibson at the Freeman/University. Each had respect for the other, but there was a healthy edge of academic rivalry which raised the stakes in terms of doing good research and presenting it globally. It was a tremendous learning environment. I can remember often going by car with Therese Small to Cotes Lab at the University in Newcastle to loan cylinders of Morgan test gas and passing his office which was neatly organised with books, papers, box files – a template of his own mind no doubt!

I was first introduced to John Cotes when I presented my first ever research talk at an evening regional research meeting at Shotley Bridge Hospital, near Consett, on the validation of oximetry in OSA. I remember John getting up at the end and praising the presentation and research – I was blown away, that this "guru" of lung function had even noticed me being there! But that encouragement and support was something John always gave young researchers. His precise, almost breathless voice was full of inspiration, ideas and enthusiasm, and he was always a font of knowledge of the most obscure papers and studies around the subject you were looking at. He connected with all the great and small of respiratory physiology from around the world, which explained his huge capacity of knowledge of the subject. At conference he always had time to tell you about his latest idea/project and wanted to know what you were up to, to see if he could offer advice.

His contribution to clinical respiratory physiology is difficult to capture because it was so immense. His work at the MRC Pneumoconiosis Centre in Llandough was where he worked on developing the Morgan Respirometer which became the standard UK gas transfer testing device in the UK (Remember the Morgan Model B, C and Benchmark that were the mainstay of many UK lung function labs in the 1970s and 80s?). It was John's vision and understanding of both the physiology and how to make the measurement that helped get the standardised test adopted globally.

He advised on the first successful conquest of Everest by Edmund Hillary and Sherpa Tenzing in 1953, with regards to the provision of oxygen cylinders and masks. John is mentioned in numerous books on the first ascent of Everest. He was the "go to person" regarding respiratory

physiology in the 1950s to 1980s. His work on reference values, and lung function decline in shipyard workers was ground-breaking and only stopped because Thatcher closed the North-East shipyards (her only constructive contribution to healthcare by default!).

He worked with many great medical scientists including Archie Cochrane (Yes, that Cochrane of Review fame!), Charles Fletcher (Fletcher & Peto fame), Heinz Wolff, Moran Campbell; but the numbers of young doctors, scientists and physiologists who have gone onto greater things is endless.

I went to see him concerning which reference values I should use for my MSc thesis on Lung Function in Diabetes. I went for a 30 minute meeting and stayed all morning. John would go to box files on his top shelf and pull the original data sheets on the subjects who contributed to his healthy controls for the Cotes gas transfer and spirometry reference values. I remember the female gas transfer box only having about 20 subjects in it! He was incredibly helpful, supportive and patient.

For a while he was somewhat out of the mainstream of respiratory physiology and there was a bit of a gap between John Cotes and the ARTP. When I became Chair of ARTP I made a point of inviting him to conference and eventually gave him an ARTP Special Award in 2002 (for which he penned a generous reply) and furthermore, we created the "ARTP John Cotes Award" for members. He received many awards for his work including the BTS medal, the ERS Educational Award and no doubt many more from overseas universities and professional bodies. It makes me wonder whether we should've been referring to "Sir John Cotes" given his contribution to our profession!

I remember John turning up to our conference in Doncaster one Thursday evening and after his presentation apologising for not staying because he had to leave to care for his sick mother - he was in his 80s then! I last saw him at one of our Hinckley conferences where he was charming, inquisitive and witty, despite being in his mid-late eighties. I don't believe he ever retired.

One special memory was after I had contributed to a few of the chapters of the Cotes 6th Edition and we were kindly invited to the book launch in Oxford. John had organised a beautiful lunch at New College in Oxford on a warm spring Sunday and we met Philip Quanjer, Martin Miller, Peter Wagner, Benoit Nemery, Kevin Hogben together with John & Sarah Cotes. It was quite surreal to be at such an auspicious occasion with leading lights in the world of respiratory physiology.

I proudly own a copy of the first edition of "Cotes" from 1965 and the latest 6th Edition. In its original form, it is a readable, enjoyable and beautifully written tome, that tells a story and keeps the young reader eager for more information. By modern standards it isn't "punchy", efficient or easy to make into an e-book, because it was from an era when clinical scientists had time to think about their field, to contemplate our understanding and to reason out answers to seemingly imponderable questions. Oh yes, his vocabulary was immense and he was a joy to listen to if you are a lover of the English language! The 6th edition is much more clinical and business-like.

John's legacy includes the hundreds of peer reviewed papers he published, 6 Editions of his book (a 7th is in process of being updated!), and thousands of technologists, physiologists, scientists, doctors and other healthcare workers across the world who learned about lung function because of "Cotes". Several of us have seen John's decline in recent years as we've been working with Sarah Cotes to complete the 7th Edition. His massive stroke a few years ago stole much of his "beautiful mind" from our world, but for a man who has contributed to science for over 8 decades and been central in the development of lung function testing around the world, he needed the peace and quiet of his home wonderfully named "The Coterie" in Durham to spend his Seventh Age.

Already I have seen many messages of respect, admiration and sadness regarding John's passing away including emails from past and present Chairs of ARTP, heads of lung function services around the world, academics, clinicians, co-authors and respiratory physicians.

To live a long life is fortuitous; to deliver and inspire so many in the way that John Cotes did, is to live the fullest of lives. John may have expired his final breath sample, but the respiratory world has held its breath at his achievement!

Professor Brendan Cooper **19th April 2018**

Upper Longdon, Staffordshire.

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Occup Med 2000;, 50: (6) 440-449.

I began working for John Cotes in Newcastle in June 1979, so have known him for 39 years. Like many others I was in awe of him and it was a great privilege being offered the opportunity of joining his team. The main brief was to investigate respiratory ill health in the North East shipyards. Other projects followed including studies of reference values, lung function and exercise responses in professional divers and patients with occupational lung diseases. We collaborated with ATS and ERS committees on standardisation issues that John considered to be of great importance. John had very high standards! He considered it essential that lung function was measured correctly using standardised procedures and properly calibrated instruments. Most importantly, he was enthusiastic about the efforts of the ARTP in improving and setting standards for our profession and always encouraged lung function personnel to join the Association.

John joined the Pneumoconiosis Research Unit (PRU) in Cardiff in the late 1940s. These must have been very exciting times for respiratory medicine. Remember, these were the days when it was thought that inhaling fumes from hot tarmac was good for clearing the bronchial tree and that lung cancer was caused by car and industrial pollution, not tobacco. John was very knowledgeable about those early days when the foundations of our measurement techniques of today were being laid. He also had a core role in developing new equipment such as the Resparameter for measuring the single breath transfer factor (note I'm not using the term 'diffusing capacity' which he did not approve of as the measurement is not a 'capacity'). In this and other matters he was pedantic. For example, he did not approve of using terms such as height and weight, instead preferring the correct terms of stature and body mass. He would argue a 70 kg man has a weight and mass of 70 kg on the surface of the Earth, but on the Moon a weight of only 12 kg due to the reduced gravitational force. However, his mass remains at 70 kg!

The PRU closed in 1985, which he decried. He wrote an article on its contribution and history which is well worth reading (Cotes JE. The Medical Research Council Pneumoconiosis Research Unit 1945-1985: a short history and tribute. Occupational Medicine (Oxford). 50(6): 440-449, 2000 Aug).

John was a good mentor and was very supportive of his staff encouraging them to achieve their best. But, he did not suffer fools easily, which I soon learned. He was astute and, in discussions, it was often apparent that he was at least one step ahead of you, which could be challenging.

John personally knew many eminent physiologists of the day and had a formidable knowledge of the literature in respiratory physiology. I have a vague memory from the early 1980s of a young medic coming to see John and I about a potential project, probably for his MD. He had noticed that when a patient stands on a weighing scale with an analogue display there is a minor

fluctuation the frequency of which is related to the patient's heart rate. He wondered if the magnitude of the amplified deflection could be used as a measure of cardiac output and hence stroke volume. He had consulted physics texts, made some basic calculations and done a literature search, but found nothing. I thought his observations and account had merit and was interested in his proposal. However, John listened carefully and congratulated him on his efforts. He then said something like "what you describe is actually called ballistocardiography and you'll find it described, I think, in the American Journal of Cardiology in the late 1950s. And the reason you won't find much on it is because it doesn't work". I don't have much recollection of what happened next. However, I do remember we discovered that the fellow had limited his literature search to the previous 10 years! The message here, and this is relevant for all of us, is to cast a wide net when researching the literature. Researchers are sometimes guilty of assuming that nothing of importance has been published in the distant past and this can be a fatal mistake. You only need to look at John's publication record over the past 70 years to be convinced of this.

John felt strongly about certain practical issues, for example, the interpretation of exercise test results. He collaborated with international committees and sometimes found himself in a minority of one! This did not deter him and he would press on with his arguments. I sometimes found myself in a difficult position because I could see both sides of the argument; the scientifically correct approach may not have been the pragmatic approach and this could raise tensions. However, John was not so set in his ways and, on occasion, would change his views in the light of argument. This, I believe, is a hallmark of a great scientist; we should accept that we do not have perfect knowledge, we should keep an open mind and be prepared to rethink when necessary.

John had moved from Cardiff to Newcastle for personal reasons. He was aged 65 in 1989 and officially 'retired'. In his presence I once referred to him as being retired. He politely pointed out that he was not retired but superannuated! Believe me, there's a difference as John was a prolific writer and researcher, remaining active up until his stroke restricted him. I did a quick search on Medline and noted he had over 40 papers and letters published, as well as completing the 6th edition of 'Lung Function' since his so-called 'retirement'.

John was a perfectionist, particularly in his writing and held strong views on what constituted 'good writing'. However, his style, which he referred to as 'Cote-ese', has been criticised as 'dense' and difficult to follow. John would make great efforts to reduce the word count, often at the expense of its comprehension. He once told me that, if he had a fault it was that he couldn't resist tinkering with text, and he did a lot of that! I felt greatly privileged in being invited to contribute to the 6th edition of 'Lung Function', which is a highlight on my CV. We did have disagreements over the writing style but, after much 'tinkering' John was finally content with our efforts and the book was published in 2006, some five years after we had started it! The 7th edition is in preparation and, though I'm not involved in it I do hope it will be a fitting tribute to

him. Incidentally, I have no doubt that John would not approve of my text here, considering it too wordy!

I never regretted my move to Newcastle and consider I am a better scientist today for having worked with John. He was loyal, generous and took an interest in my career, offering me encouragement and advice at critical times. He was more than just a colleague and I count him as a personal friend. I last saw him in June 2016 when we shared lunch at his home in Durham. Though I left the Newcastle Lab in 1993 we continued to collaborate on projects. Our last publication was in 2012, a letter to a journal about the self-reporting of height and weight!

John has influenced the careers of many who have benefitted from their association with him. It is difficult to give an accurate account of his contribution to respiratory physiology. It is extensive and, in losing John, we have lost an important source of intellectual and historical capital. We owe him a great deal. But, his presence lives on in his prolific publications, his teachings and his seminal book. We can honour him by ensuring that what we do in measuring respiratory function continues to meet his high standards and, through determined effort, in time will exceed them.

Rest in Peace, John.

David Chinn

Ever since entering P.K.Morgan Limited in September 1977, the name John Cotes was on our lips, the public announcement system at Manor Road Chatham was often broadcasting "Dr Cotes for Mr Morgan". It was some years later that my first personal contact came, this was due to Geraldine O'Connell-Ramsey, then working in St Thomas Hospital, who contacted the Morgan company to say she had located an error in the COTES LUNG FUNCTION 4th EDITION. It stated ".846 Converts Litres STPD to BTPS"; she could not make this work in a calculation.

Phillip Morgan advised "this is one for you lad, he won't bite", I phoned John and introduced myself, and then stated the problem, after a short silence he replied "well there are lots of errors if you have the time to find them"…how do you answer that? It was some weeks later before Dr Patricia Tweedale, on a visit to Edinburgh, located the problem. Having every version of Cotes ever published and her personal thesis from Cambridge dusted off from a top shelf, she proclaimed "of course, the figure is LOWER than 1 so it must convert Litres BTPS to STPD, this makes sense". The information was passed back to John who made no comment but the section changed in version 5, Patricia also confirmed versions 1, 2 and 3 had it correct!

After this initial contact, due to the many projects P.K. Morgan and the trio Cotes, Reed and Chinn worked on, I was often the "mule" taking parts, gases or information to the North East. The name "Cotes" was at every site: "Shotley Bridge Hospital – Hexham General – University of Newcastle – The Occupational Medicine Department Newcastle" not to mention his respect on the Pneumoconiosis Medical Panel.

John was always interested in new projects, new research and encouraged others through open dialogue, he was always approachable. I remember the excitement when, with Jim Reed, they obtained access to the Hyperbaric Chamber in the Victoria Infirmary in Newcastle and the projects he was inventing in his mind.

Some projects were setbacks; he mused over the Shipyard studies in Newcastle where in the Exercise test the subjects would stop pedalling for no reason; when questioned they responded, "well getting to work is down hill and we free wheel, going home we pedal the uphill parts and when our legs are tired we free wheel".. how to add that to the study data?!

John was instrumental in the development of the first SMALL PFT system, the TRANSFLO, in the early 1990's. He needed a small device for Transfer Factor, Spirometry and Lung Function that could work with a single cylinder of gas and travel on the small helicopters that service the North Sea Oil rigs. This was built, tested and validated by him and changed the face of instrumentation as, after being shown commercially at the ATS in Boston in 1994, the Sensormedics team followed the concept with the birth of the Vmax.

John was a regular face to every meeting and you would expect from the chair of every meeting, the call "Dr Cotes you have the microphone".. John had a comment to submit to every session he attended and these were always well received.

His last great work was to be a follow up to his early work with Jim Reed on the fact that Submaximal Exercise tells as much as Full Stress testing, as he told me once, "The linear relationship of Work, Heart rate and Ventilation tells us that if you under perform at the start you will not dramatically improve by the end of the test and if you over perform at the start of the test then you will still over perform at the end of the test if you are fit, so you do not need to do a maximal test to make an initial Clinical Diagnosis".

The achievement of the publication of the 6th Edition of Cotes Lung Function he marked by returning to Oxford University where he put on a Lunch for family and invited Guest. I was lucky enough to join that event and he made us all like family, it was truly a moving lunch, I think it was Philip Quanjer who, in his address to John, gave us all the news Dr John Cotes is actually Prof. John Cotes—whilst never being given a Chair in the University of Newcastle, it appears in the cold war days his visit to the University of Warsaw in Poland did indeed see him given a Chair and title of Prof. Something which he never used.

We will miss his direct wisdom and it remains to only learn and appreciate his life's work through his books and publications.

The UK will always remember, on returning from his period in the USA, he gave us, " Diffusion is a general term for all methods of Diffusion, whilst to use the term TRANSFER FACTOR specific to the Single breath Transfer Test, best describes the snap shot in time for this period of diffusion"

Long may TRANSFER FACTOR remain and John's Memory with it. Whilst he has moved on to a better place, he leaves a legacy of work for us all to follow.

Kevin Hogben

This is sad news and the world has lost firstly a great person and secondly a great scientist, to whom we all have and will continue to refer to and look up to.

My first encounter with John was back in early 1977. I was a trainee/student still in my second year of ONC and had recently started in Respiratory Measurement at Seaham Hall Hospital. Being very new, I had been given a copy of Cotes 2, which I was trying to read, albeit with some difficulty due to its interesting stylistic presentation. One afternoon one of the medical consultants popped into the lab with this tall, slim gentleman and introduced him as Dr John Cotes. John was informed that I had just started in the field. He was totally charming and welcoming, was delighted that I was reading his book, pointing out that there a new edition (1975) and that also I was using a full Haldane gas analysis system and that I had a Mk4 Respirameter – for those not familiar with the Mk 4, the schematic is on page 305 of Cotes V. He talked a little about the equipment, noticed I had a cycle ergometer and a gas meter and enquired whether I was doing exercise testing yet. I said that I wasn't at that time – that actually happened 2 weeks later! To say I was in awe, is perhaps a total understatement – more like totally gobsmacked! John welcomed me to the field of Respiratory Physiology and hoped I would continue in it and to do well.

Having them moved to Freeman Hospital in late 1977, I met up with John on a number of occasions. He gave a teaching session and covered the topic of lung function interpretation and the application of exercise testing. His style of presentation was clear and concise and I came away with lots of information. One bit I do recall was that one of his patients had had some respiratory illness and John had been asked whether this patient was fit to continue his work walking round and up and down the outside of a gasometer. John clearly explained that this patient's CPET test was such that he did not have enough reserve as he needed X L/min VO_2 to do his job, but needed in case of emergency some additional VO_2. Simple and obvious in reality, and something I took away and use today.

I actually applied to work in John's lab at Newcastle at one point whilst still at Freeman. For some odd reason I chose to decline the offer. John showed me his new lung function laboratory along with Jim Reed and David Chinn. This was a mobile lung function lab in a large trailer, pulled by a long-wheelbase Land Rover. If I recall you walked in one end of this truck, did some resting lung function tests, it had a treadmill, which you walked on for an exercise test of some sort – and then you did some more tests at the other end. It was Heath Robinson and totally awesome. The team used this to study his shipyard workers.

Having moved to Bristol in 1982, I saw John at various meetings, including the ARTP meetings. We always chatted and exchanged thoughts. Just listening to him talk always remained awe-

We always chatted and exchanged thoughts. Just listening to him talk always remained awe-inspiring. I still use his take-home messages and listened intently to anything he asked from the floor - "Dr Cotes at the Microphone".

One meeting I do recall was a Physiological Society meeting in Cardiff, which I attended simply because John was presenting. John was scheduled to give a presentation on some of the inconsistencies in respiratory measurement. The audience included many respiratory and exercise experts including Brian Whipp. Mathematical issues and physiological issues were raised and presented in a subtly provocative way. He debunked some of the things we had thought true. It was a brilliant presentation and certainly created a lot of discussion, which eventually the chair had to rein in with pointers regarding coffee time and that some attendees might like some of the audience to view their poster presentations!

At one ARTP meeting, John was very apologetic about having to leave early. His reason was that his mother was unwell. Some of us tried to work out how old he was, and therefore how old his mother was! That wonderful underplayed comment still remains in my memory vaults.

A T-shirt was presented to John at the first Brighton meeting, in 2006, by Paul Enright – displaying a message to the effect that he was still with us in the world of Respiratory Physiology – I recall being personally rather mortified that someone actually thought that was even appropriate. However, at breakfast the next day I recall John wearing it and in discussion with him, he was actually amused and delighted with it and he wore it at subsequent meetings with pride and amusement.

The last time I spoke with John was at his last ARTP meeting. We had talked over breakfast about submaximal indices of exercise testing and how he wanted these to be used in clinical practice. Breakfast lasted a long time, the conversation was intense and provocative (in a nice and positive way) and he was very enthusiastic and full of ideas. At the end of the Friday sessions I spoke briefly with John for the absolute last time. Whilst he was amazing he was beginning to wind down and suggested that this might be his last meeting. I thanked him and I hoped to see him back next year – but sadly that never happened.

I'm left with part of his legacy on my desk at home – a chapter in his latest edition of his book that I was asked to edit. This was about two years ago and this project has just been resurrected. It saddens me that this book will now be published after his death, but at the same time will be a fitting legacy to his huge contribution from its 1st edition published in 1965 to date.

A true great – RIP John

Adrian Kendrick


Clinical Tests of Respiratory Function

Reprinted from **THE LANCET,** *September* 18, 1965, *pp.* 573-575

https://www.sciencedirect.com/science/article/pii/S0140673665908743

New Inventions

AUTOMATIC MEASUREMENT OF LUNG FUNCTION

TESTS of lung function are of value for the diagnosis of all cases of persistent breathlessness on exertion, for the control of treatment, and for prognosis; and they contribute to the assessment of disability and to the protection of individuals who, during the course of their work, may inhale noxious dusts and vapours.

In medical practice, as distinct from research, the assessment of lung function has often been held up by lack of automatic apparatus. This obstacle has been overcome for ventilatory capacity.[14] We describe an apparatus which increases the reproducibility and simplifies measurements of lung volume and transfer factor (formerly called " diffusing-capacity of the lung ").[15]

THE APPARATUS

A new apparatus (fig. 1) comprises a closed-circuit spirometer with chart recorder for measuring subdivisions of the total lung-capacity, and a valve-box assembly incorporating automatic sampling for measurement by the single-breath method of the transfer factor and its subdivisions (including the diffusing capacity of the alveolar capillary membrane and the volume of blood in the alveolar capillaries). The equipment can also be used to provide single-breath indices of uneven ventilation and perfusion.

At the start of each measurement the patient inhales a gas mixture and exhales to atmosphere. The operator then switches into the closed circuit or one of the single-breath procedures. Thereafter the operator instructs the patient in the respiratory manoeuvres required while the recording and operation of the apparatus is controlled automatically. The apparatus has a low resistance to gas-flow and is transportable (weight 36 kg., dimensions 46 x 46 x 61 cm.). It is used in conjunction with gas analysers for helium, carbon monoxide, and, in some tests, oxygen, carbon dioxide, or other gases.

The apparatus is made up of a number of units, each of which can be detached for maintenance. The units include a 5-way-valve box with gas inlet and outlet ports controlled by solenoid-operated valves and bags for sampling the alveolar gas. a tap assembly with linked manual controls, a kymograph, spirometer, and other instruments, a volume detector, comprising a photo-cell energised by a light beam which is interrupted by blanks on the pulley wheel of the spirometer. and an electronic control box. This box operates the electromagnetic valves, in response to signals from the volume detector in one of several predetermined sequences. The time of opening and closing of the valves is less than 0.1 second and the standard deviation of the volumes obtained is approximately 50 c.cm. The general lay-out is shown in fig. 2 in which the taps are in the positions they occupy during measurements of the functional residual capacity. The taps are operated by two controls, one for A and C and the other for B, D, and E together.

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Open-circuit System

The patient inhales either air or oxygen through tap A and exhales through tap C to atmosphere or into other equipment. In these positions of the taps at gas flow-rates of 85 litres per minute the back pressure during expiration is 2·2 cm. water and the suction during inspiration from air is 2.5 cm. water. These resistances are low enough for use during moderate exercise.

Closed-circuit System

This part of the apparatus comprises: a water spirometer with a 7 -litre bell of diameter 20 cm.; a chart recorder which uses standard teleprinter paper and has chart-speeds of 1 cm. per second and 5 cm. per minute and a deflection of 3.2 cm. per litre; and a soda-

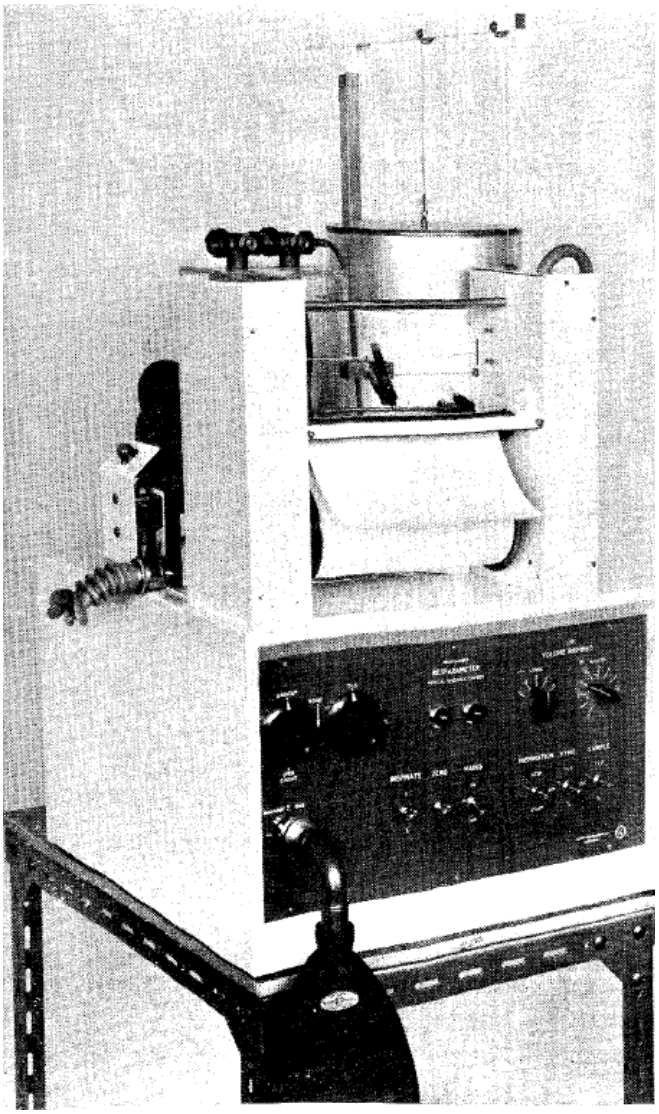

Fig. 1—The apparatus.

lime canister, a rota-meter for monitoring the added oxygen, and a pump for circulating the gas through the helium katharometer. The apparatus deadspace is approximately 2 litres; this is small enough so that during rebreathing, adequate mixing of gas occurs in the apparatus without the use of a circulating fan. At other times mixing is effected by displacing gas to-and-fro between the bell of the spirometer and the bag (also used for oxygen washout), which for this procedure is plugged into the mouthpiece.

To measure lung volumes the closed-circuit apparatus is normally filled with a mixture of helium in air and used in the standard way.[16] Alternatively the apparatus may be filled with helium in oxygen and the measurement taken in conjunction with that of carbon-monoxide tension in equilibrium with mixed venous blood.

METHOD

Measurement of Transfer Factor by Single-breath Method

The procedure is a further modification " of the test devised by Forster and his co-workers.[18 19] The patient inhales a breath of test-gas mixture which typically contains 18% oxygen, 12% helium, and 0.2% carbon monoxide, in nitrogen. The breath is held for a predetermined time, then during exhalation a sample is collected and later analysed for helium, carbon monoxide, and oxygen. With the new apparatus the controls are pre-set to: **(1)** the required volume of inspirate, usually 250 c.cm. less than the vital capacity; (**2**) the time of breath-holding, usually 10 seconds; (**3**) the volume of gas used to flush the anatomical deadspace, usually 700 c.cm.; and (**4**) the volume of sample for analysis, usually 500 c.cm. Evidence for the need to control these variables is summarised elsewhere.[20] The procedure may be carried out in duplicate. At the end of one or both tests each sample of alveolar gas is passed through the analysers by the pump, the tracings are measured, and the results calculated either by hand or by an electronic computer. The details of these and other calculations and the precautions necessary to obtain accurate results are described by Cotes.[21]

Measurement of Single-breath Index of Uneven Ventilation and Perfusion of Lungs

This index is based on the work of West et al.[22] and Read.[23] Their technique has been modified to allow for the changes in gas concentration which occur during inspiration and expiration; neglect. of this aspect in the past has led to overestimation of the inequality of distribution in persons with normal lungs.[24] The patient inhales a predetermined volume of test gas from functional residual capacity, then immediately exhales. The gas is normally analysed by a mass spectrometer. Instead, with the new equipment, two samples of alveolar gas are collected during expiration and later analysed with standard equipment.

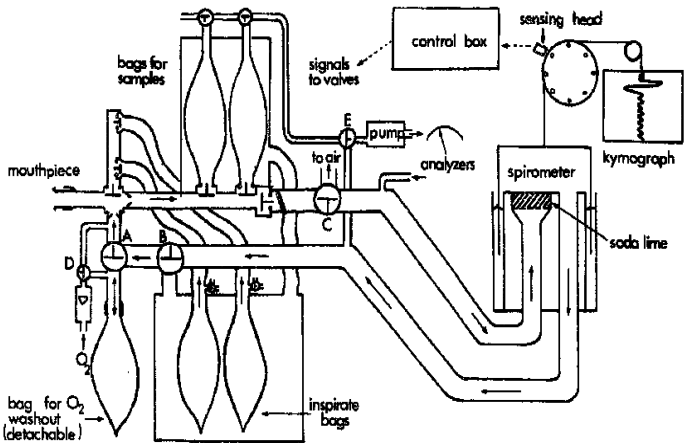

Fig. 2—Diagram showing layout of apparatus with taps in position as for test of functional residual capacity.

DISCUSSION

These applications indicate the versatility of the new apparatus but not the limits of its development since, by altering the control box, any sequence involving not more than two inspirates and two alveolar samples can be obtained. We have found that use of the apparatus simplifies and improves the reproducibility of serial measurements of the transfer factor, the diffusing capacity of the alveolar capillary membrane, and the volume of blood in the alveolar capillaries. Its use should improve the comparability of results between different laboratories, although to this end maintenance of high standards of gas analysis is of greater importance.[25] Good reproducibility is particularly important for comparative studies, for assessment of disability, and for those who during the course of a Chronic illness may have measurements made at a number of laboratories.

SUMMARY

This paper describes a new apparatus which combines open and closed breathing-circuits with equipment for carrying out single-breath studies in which samples of alveolar gas are required later for analysis. The equipment includes control of the volume of inspiration, the time of breathholding, and the size of the samples and their position with respect to volume from the start of expiration. In conjunction with analysers the apparatus is used for measurement of the lung volumes, the transfer factor (diffusing capacity of the lungs) and its subdivisions, and· the single-breath index of uneven distribution of lung ventilation and perfusion.

We thank Miss A. Hall and Mr. D. Thomas for technical assistance, and Mr. R. T. Harris for photography. The apparatus will shortly be available from Messrs Lloyds Instruments Ltd., 6, Furrow Lane, Homerton, London, E.9.

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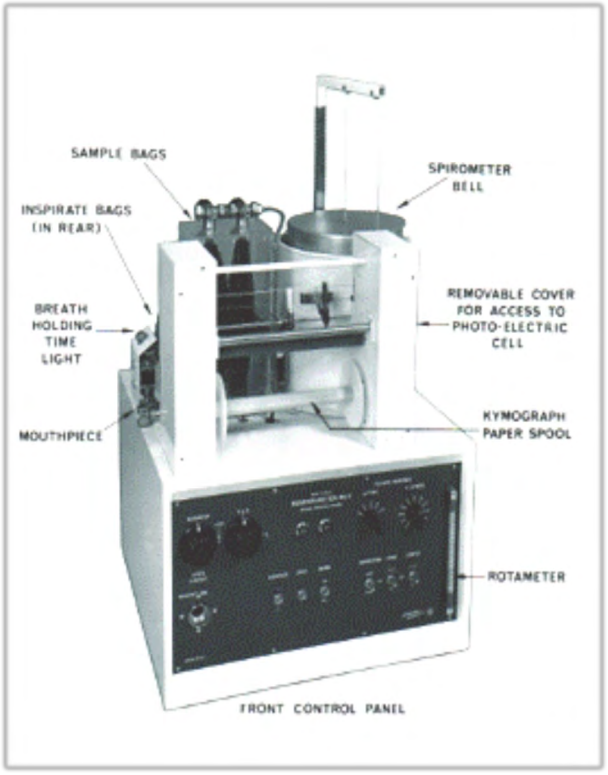

Improved image of the Resparameter—with thanks to Kevin Hogben

A RETROSPECTIVE REVIEW TO DETERMINE IF GAS TRANSFER MEASUREMENTS SHOULD BE CORRECTED FOR EXHALED CARBON MONOXIDE CONCENTRATIONS

S S Mathew, M Bucknall, T Fleming, C Wood.

Introduction

This retrospective review investigates the significance of correcting single breath gas transfer measurements made on the Jaeger Masterscreen equipment for baseline carbon monoxide levels. It evaluates the appropriate time a patient should stop smoking for prior to performing a single breath gas transfer test.

Current guidelines[1] recommend correcting gas transfer measurements for percentage carboxyhaemoglobin levels in the blood (%COHb) of greater than 2% to ensure accurate measurement and interpretation of the TL_{co} and K_{co} results.

As part of this review, a short survey was conducted to investigate current practice about the adjustment of gas transfer test for exhaled carbon monoxide levels in lung function departments. 9 out of 11 (82%) lung function departments in the UK responded that they do not correct TL_{co} and K_{co} for exhaled CO in routine clinical care. In addition, 8 out of 11 (73%) lung function departments advise patients to refrain from smoking for at least 24 hours prior to testing.

The practice of asking patients not to smoke prior to their appointment may be one of the reasons for some patients not attending their lung function appointment at the hospital where this research was conducted, as the patients feel anxious that they could not comply with the pre-test instructions. The percentage of patients that did not attend their appointment was noted to be 16.5% in 2015/16. This is a waste of resource in a busy department and leads to increased waiting times.

Methods

The data required for this review was collected retrospectively from the lung function department in King's College Hospital, London as part of a smoking cessation awareness initiative. Single breath gas transfer test results and baseline carbon monoxide readings were collected from 200 patients with varying degrees of lung function impairment and smoking status between September and December 2016.

Gas transfer tests were measured using the single breath technique using Jaeger Masterscreen PFT equipment, (software version 5.72, fast gas analysis option).

The test gases used to measure TL_{co},V_A and K_{co} were 0.28% CO, 0.28% Methane, 21% O_2 and nitrogen balance. In addition, the discard volume was set to 800mls and the sample volume was set to 650mls. The sample and the discard volume was adjusted depending on the patient's measured VC.

The Jones Meade breath-holding time was used to calculate the SBGT test results, which includes 0.3

of the inspiratory time and half of the sample volume time[2].

The SBGT results were corrected for Hb levels using the HemoCue Hb 201 DM analyser[3], which can measure Hb ranges of 0 - 256g/L.

Baseline exhaled CO was measured using Bedfont piCO smokerlyzers[4] in routine clinical practice prior to the SBGST test to encourage smoking cessation.

The ECCS 1993 regression equations were used to calculate the TL_{co} predicted value and normal ranges for the patient data presented in this review.

All tests were performed in accordance with ATS/ERS guidelines[2]**.** All measurements were recorded by skilled and experienced clinical physiologists.

Results

Correcting gas transfer test results for baseline carbon monoxide levels measured within 15 hours of smoking increased the measured gas transfer results.

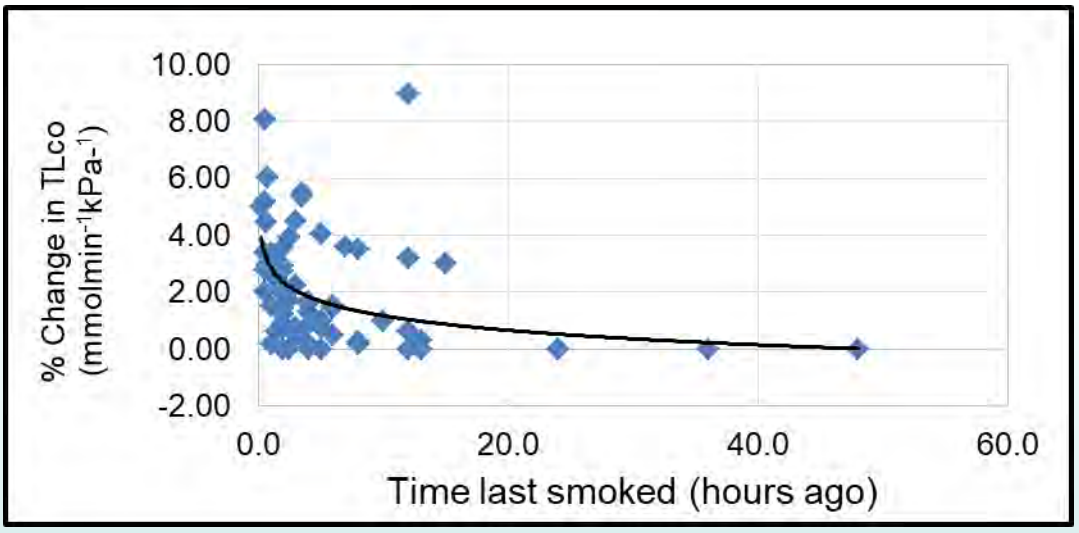

Figure 1: Percentage changes in TLco Vs time last smoked in current smokers.

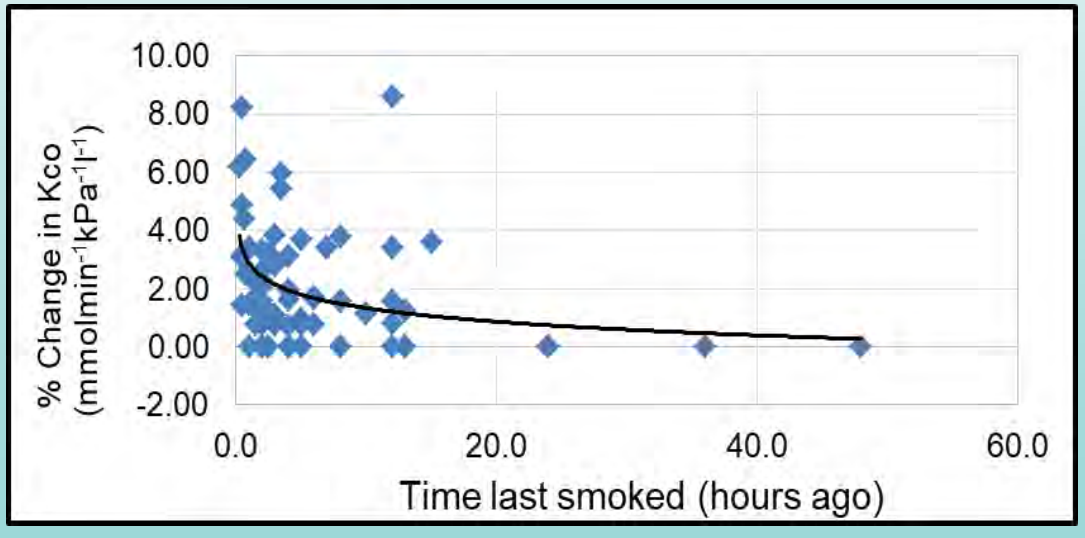

Figure 2: Percentage changes in Kco Vs time last smoked in current smokers.

There was no clinically significant change in baseline gas transfer results for up to 2% carboxyhaemoglobin in current, ex and non-smokers.

Only 8 (4%) patient's had their gas transfer disease severity changed after correcting for carboxyhaemoglobin. They were current cigarette smokers with an exhaled carbon monoxide level ≥30 parts per million (5.43% carboxyhaemoglobin).

Patient ID	Smoking status	Spirometry severity	Time last smoked prior to testing	COppm (% COHb)	Change in disease severity (SR's)	Change in disease severity (TLco % predicted)
SBGT 21	Current cigarette smoker	Severe obstruction	30 minutes	39 (6.9)	Severe (-3.63) to moderate (-3.49) change in TLco	n/a
SBGT 15	Current cigarette smoker	Mild obstruction	8 hours	30 (5.4)	Mild (-1.67) to normal (-1.53) change in Kco	Moderate (59.7%) to Mild (61.8%)
SBGT 23	Current cigarette smoker	Moderate obstruction	48 minutes	45 (7.8)	Mild to (-1.81) to Normal (-1.64) change in Kco	Moderate (59.7% to mild (63.3%)
SBGT 46	Current cigarette smoker	Mild obstruction	20 minutes	39 (6.9)	Moderate (-2.61) to mild (-2.48) change in Kco	n/a
SBGT 192	Current cigarette smoker	Normal	2.5 hours	32 (5.8)	Mild (-1.66) to Normal (-1.53) change in Kco	n/a
SBGT 28	Current cigarette smoker	Normal	7 hours	31 (5.6)	n/a	Moderate (60.2%) to Mild (62.4%)

Table 1: Data with changed disease severity after correcting for %COHb levels

Discussion

This review agrees with Wald et al[6] as ex-smokers and non-smokers had similar COppm and %COHb mean and ranges. 6% of the ex-smokers and 19% of the non-smokers enrolled into this review had an exhaled $CO_{\geq}$ 7ppm (1.75%COHb) which is above the non-smoker range of 0-6ppm according to the Bedfont cut off values[4].

This may have resulted from having a faulty appliance e.g. faulty boiler, passive smoking or a drift in the piCO sensor (Bedfont, 2016). As this study was objective, it is feasible that some patients may not honestly declare accurate information about their smoking status accounting for their raised baseline, exhaled COppm levels.

This study shows that correcting for COHb levels of < 2% (< 11ppmCO) doesn't change the TLco and Kco measurements. This review agrees with the ATS/ERS 2017 guideline which doesn't recommend the correction of gas transfer measurements in patients with %COHb levels of <2% as the reference equations takes this into account (Graham *et al*., 2017).

Correcting for %COHb in a current smoker with an exhaled CO of 60ppm (8.94%) caused an 8.9% increase in TLco and an 8.6% increase Kco. This agrees with the ATS/ERS 2017 guideline of correcting TLco and Kco being corrected in patients who have a raised %COHb of >2% (Graham *et al*., 2017).

This review shows that correcting for %COHb caused a greater change in disease severity of current smokers in Kco when interpreted using SR's in comparison to TLco when interpreted using SR's or TLco percentage predicted.

8 patients that did have their TLco and Kco disease severity changed after correcting for %COHb were all current smokers with an exhaled CO of >30ppm (Range = 30 - 45ppm) as demonstrated in Table 1. This agrees with Knudson *et al*[7] who reported a greater reduction in baseline TL_{co} in current smokers than in non-smokers and ex-smokers.

Correcting for carboxyhaemoglobin caused a change in TL_{co} of ≥5% in 3.5% of the data used in this review. This 3.5% were all current smokers.

Table 1 emphasises the importance of the criteria used to interpret the gas transfer test results. Table 1 shows that 1 patient had their TL_{co} disease severity changed when interpreted using SR's. However, 3 patients had their TL_{co} disease severity changed when interpreted using TL_{co} % predicted. In addition, no patients had their TL_{co} disease severity changed when interpreted using both SR's and TL_{co} % predicted.

Figure 1 and 2 shows that patients who smoked within 15 hours prior to their SBGT test should have their measured TL_{co} and K_{co} values corrected for %COHb as this can change their baseline TL_{co} and K_{co} values. This agrees with Wald *et al* that recommends a correction of %COHb for a maximum of 24 hour smoking history.

Correcting TL_{co} and K_{co} for %COHb for a 15 hour smoking history prior to the SBGT test has the potential to reduce the number of patients that do not attend their lung function appointment due to anxiety of not complying with the pre-test instructions. In addition, it can correct for %COHb in patients who did attend their appointment without complying with the pre-test instructions, making their test results more accurate. Exhaled COppm of >10ppm is considered as a smoker according to the Bedfont cut off values[4]. 80% of the current smokers enrolled into this review had an exhaled CO ≥10ppm and had smoked within 15 hours prior to the SBGT test, not complying with the pre-test instructions of the SBGT test.

Conclusion

In conclusion, these results prove that there is no need to correct for %COHb levels of less than 2% as it doesn't change the baseline values of TL_{co} and K_{co} in current smokers, ex-smokers and non-smokers. Furthermore, this review emphasizes the need to correct for %COHb in current smokers who smoked within 15 hours prior to the SBGT test as it can increase TL_{co} and K_{co}. This will ensure accurate diagnostic test results, which can then aid in clinical diagnosis, management and treatment of patients by clinicians. Lung function tests should be interpreted by the clinician in line with other test results, clinical examination and the patient's medical history.

Respiratory illnesses place an economic burden of around £9.9 billion on the NHS[8]. Recording accurate baseline measurements by correcting gas transfer tests for carboxyhaemoglobin levels especially in current smokers may reduce this burden by not having to send patients for additional diagnostic tests like a chest x-ray. Although buying a PiCO Bedfont smokerlyzer does have an initial cost of around £155, buying disposable D pieces (x12) and SteriBreath mouthpieces (x 250) will cost £55.94[9]. This is only 22 pence per patient. This is cheap and a good way to encourage smoking cessation while ensuring accurate baseline measurements are recorded.

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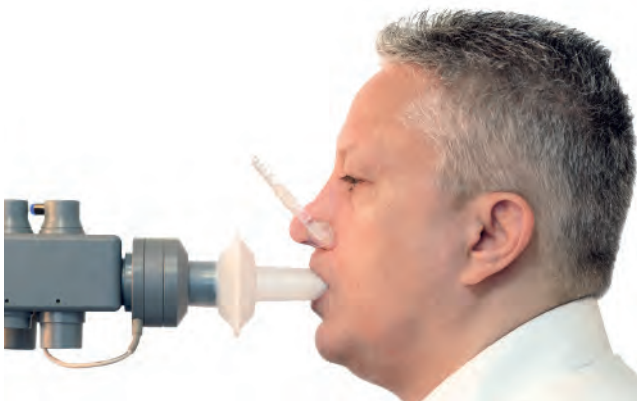

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Researcher Development for Healthcare Scientists – developing the potential of physiologists as researchers

Samantha Irving, Chief Paediatric Respiratory Research Physiologist

Royal Brompton Hospital, London

Although many of us feel as physiologists we should be involved in research, actually becoming involved is somewhat more difficult. The importance of research to the NHS is highlighted by its' inclusion in the Constitution[1]. The National Institute for Health Research (NIHR) and Health Education England (HEE) have recognised the importance of research, and researchers, to continuing to develop best practice. Their integrated clinical academic (ICA) programme, aimed at developing clinical academics from nursing, healthcare science and allied health professions, specifically states:

"A truly multidisciplinary workforce is key to the future of the NHS and the same is true of the clinical academic workforce. It is vital, therefore, that all health professionals play their part in driving and leading research activity, ensuring that clinical research has the potential to pervade and benefit the care pathway in its entirety."[2]

In the ARTP generic job descriptions for respiratory clinical physiologists and scientists, all grades from Band 3 to 8 contain a suggested Research and Development domain. This ranges from contributing to departmental research where appropriate at Band 3 and presenting audit at local meeting at Band 4, to presenting outcomes of their own research at national and international meeting at Band 5 and 6. Band 7 asks the applicants to devise research, grant and ethics application, and a Band 8a should be expected to manage and provide strategic direction to an on-going and successful research programme.

However, despite this, relatively small numbers of healthcare scientists are involved in research. For the ICA programme in 2015 and 2016, just 15% of applications were from healthcare scientists of any background.

The barriers to staff becoming involved in research are complex and multi-factorial. Increasing clinical workload and tighter time constraints on our work undoubtedly plays a role, but other factors such as a perceived lack of generic research skills, lack of funding to attend meetings or conferences, or just a simple departmental culture of non-participation in research can all contribute.

In 2017, the Academic Health Science Centre at Imperial College pioneered a Researcher Development Course, aimed at healthcare scientists (including physiologists), allied health professionals and nurses who wished to improve their research skills and understand the steps involved in furthering their careers in research. The Academic Health Science Centre works with three partner NHS Trusts, and applications were received from across theses Trusts and from many different professional groups. The course was delivered over 2 half days and 1 full day, spaced out over 3 months, which it was felt would allow participants to better attend without causing disruption to their clinical area.

In total 47 applications were received, from 11 HCS, 20AHPs and 16 nurses.

In advance of the first session, attendees were asked to give their expectations of the course, these are summarised in Table 1, below.

Attendees' Desired Learning Outcomes	Responses
Getting started in research	29
Paper/abstract/proposal/hypothesis writing	18
Funding/Grant applications	14
Research methodologies	12
Statistics	10
Start masters/PhD qualification	10
Literature search/review	7
Ethics/patient consent	4
Getting published	4
Desire to improve patient care	4

Points to consider running a course

Embed the course in meetings and teaching already within the Trust, don't rely on email alone to get the word out

Coaching and small group cohorting allowed tailored advice and support for all attendees.

Hands on and interactive teaching to help reinforce concepts and encourage confidence more so than traditional lecturing.

Celebrate the achievement of participants in completing the course.

Sessions covered in the course included hypothesis generation and types of research study, referencing and literature searches, public and patient involvement, statistics and hypothesis testing, qualitative and quantative research, abstracts and publishing, and funding and research degrees.

Participants were asked for feedback on each of the sessions. When asked how interesting they found the content (Very interesting, Quite interesting, Not very interesting, Not interesting), 64% of participants found the course very interesting, with the remaining 36% finding it quite interesting. When individual sessions were assessed for content and deliver on a scale of 0-5, the average score was 4.5.

There were several points about the course's structure and organisation that allowed it to be delivered so successfully, and these themes were identified as positive points in the feedback received from participants.

Firstly, the course organisers identified individuals in the partner Trusts who were able to help promote the course, and arrange meetings of various professional groups the organisers could attend to introduce and explain the course to the target groups. This allowed the course to feel embedded in each of the partner trusts, gave potential participants the opportunity to ask questions, and generated more interest than emails or posters alone would have done.

In addition to the main teaching sessions, participants were divided into smaller coaching groups. These

groups were cohorted by research experience to allow these smaller sessions to be more individually tailored to participants' needs. Each group was facilitated by a research coach; a healthcare scientist, allied health professional or nurse drawn from the partner Trusts who is actively involved in their own research. The coaches were given some formal training in coaching techniques, as well as their own research experiences to draw on, to provide participants with the help and support needed. The usefulness of these groups was a common theme identified in feedback from participants, in particular the opportunity to hear the research journey of the coach, to talk through their own project plans and to meet other people in a similar position was considered particularly valuable.

Several sessions, particularly those on complex topics like statistics, were based on hands on practical demonstrations using worksheets, and each session was followed by non-compulsory "homework" to allow attendees to put their learning into practical use. This helped to reinforce complex topics in a way that purely delivering a non-interactive lecture session would not have been able to achieve.

Finally, at the conclusion of the last session, attendees were presented with a certificate from the Head of Faculty, and an informal networking session and party to celebrate their achievement was held, to better foster the development of a community of HCS, AHP and nurse researchers across the Trusts.

Although this programme has been small in scale, it is clear it has made a difference to the attendee's perception of research, and their confidence in their skills, which is an effect that could be replicated in other centres.

There remains many challenges to healthcare scientists becoming researchers. Until relatively recently, although funding could be obtained for Masters or Doctoral degrees, anyone wishing to conduct research beyond that would very likely have had to leave their clinical appointment in favour of university employment, often on short fixed term contracts. This contrasts to the experience of most of our medical colleagues, for whom joint appointments and remaining in clinical posts is common practice.

There are attempts being made to address this, to allow healthcare scientists, allied health professionals and nurses to develop true Clinical Academic roles with joint appointments between universities and Trusts. The new NIHR/HEE ICA Fellowships aim to support researchers at the pre-doctoral, Doctoral, Lecturer and Senior Lecturer level, with awards allowing researchers to carry out their projects, develop their own research and transferable skills, and remain employed by their Trusts. Increasingly, grants awarded by charities are accepting applications from scientists and other professionals alongside medics, and some even have specific awards solely for projects led by non-medics.

As healthcare scientist led research is undoubtedly a growth area within the NHS, respiratory physiologists are well placed to increase our impact in this area. Unlike many healthcare scientists, we are patient-facing and much of our research is inspired by our day to day practice with patients and their families, and in an environment where patient reported outcomes have increasing prominence, this is a great strength. Physiology requires well developed numerical skills which can be easily transferred to handling large datasets or

PARTICIPANT FEEDBACK

"Wow! Great delivery, engagement on some difficult subjects. Best explanations I have encountered"

"The interactive session during 2nd tea break was really good to work through, the example gave me confidence boost in stats."

"Mostly love the homework and the feedback & help from mentor"

"Taking us through a 'journey'! Allows me to think and shape my own research project idea."

"Working in coaching groups to help start applying what we're learning into our own work/projects"

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2. NIHR Trainees Coordinating Centre. Guide to the Health Education England National Institute for Health Research Integrated Clinical Academic Programme

performing statistical analysis. We often work in teams with varied experience and expertise and so are in a position to establish collaborative projects. And, finally, with support for the development of the clinical academic role, we now have the structures available to ensure we can participate fully in these developments and help shape research in respiratory conditions in the future.

NEW SPIROSENSE® FROM PARI

Precise spirometry for all ages

- Modern hot-wire technology ensures high measurement accuracy, even at low flow rates [1]
- Child-friendly animation helps patients with correct breathing technique [2]
- Includes new GLI reference values for children from 3 years old [3]
- Intuitive, easy-to-use software
- Automatic self-calibration

1: Friedrich P., College for Applied Sciences, Faculty of Electrical Engineering, Kempten, Internal Report 2014.
2: Dormeyer, C. et al 2014, Allergologie, 37(4), 161. 3: Quanjer PH et al. Eur Respir J. 2012; 40:1324–1343.

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113D0714

CONTINUOUS LARYNGOSCOPY EXERCISE (CLE) TEST TO DIAGNOSE EXERCISE INDUCED LARYNGEAL OBSTRUCTION

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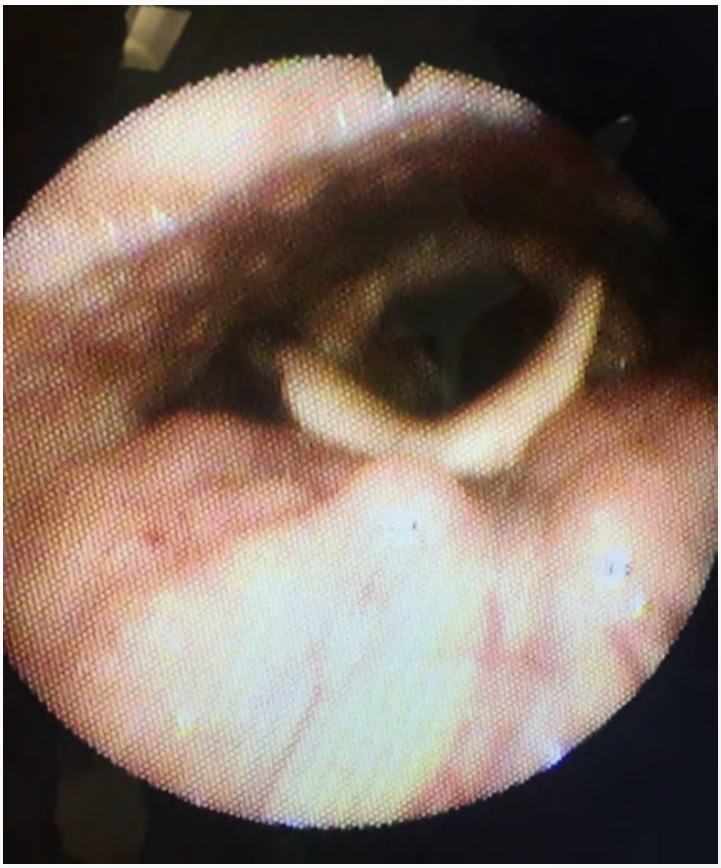
Introduction

The larynx is a highly innervated organ that links the pharynx and trachea. The vocal cords sit in the central glottic region of the larynx with the thyroid and corniculate cartilage above and the cricoid cartilage below. As well as facilitating speech and swallowing, the larynx protects the airway from swallowed food and liquids. At any one time laryngeal diameter depends upon the underlying cartilaginous structure and



neuromuscular control of the vocal cords and supra-glottic structures. During exercise, as ventilation increases, we expect the laryngeal structures to abduct and increase the cross sectional area of the airway to facilitate increased airflow. However, in some individuals the larynx becomes ‘dysfunctional’ during exercise and obstructs the upper airway; this typically happens at or close to peak exercise and seems to be more common during intense competitive events. The process is termed exercise induced laryngeal obstruction (EILO)[1]. EILO may be caused by adduction of the vocal cords, the supra-glottic structures or a combination of the two[2]. As EILO reduces airflow it can severely limit exercise tolerance and lead to a variety of respiratory symptoms on exertion including dyspnoea, stridor, wheeze and throat discomfort. EILO is most commonly observed in young, athletic individuals[2, 3].

When described, the symptoms elicited by EILO may sound very similar to those caused by exercise-induced bronchoconstriction (EIB) and the two can be difficult to differentiate[2]. Broadly speaking, EILO occurs and induces symptoms close to peak exercise whereas EIB tends to occur once the patient stops exercising[4]. While EIB causes an expiratory wheeze, EILO tends to produce stridulous sounds on inspiration. Although a number of studies have documented the coexistence of EILO and EIB[2, 3], a differential diagnosis is important so that the patient can be appropriately managed. Symptoms alone are often insufficient to differentiate between EILO and EIB[2]. There is also poor correlation between a diagnosis of EILO and both baseline spirometry results and analysis of pre- and post-exercise flow-volume loops [5, 6].

The continuous laryngoscopy exercise (CLE) test is considered the gold standard diagnostic test for EILO[7]. It involves placing and securing a laryngoscope in the nasopharynx and observing the patient's upper airway during a continuous, symptom-limited exercise test. The presence and severity of EILO is assessed by visual inspection either during the test or during a post-exercise video replay. EILO is diagnosed when, during exercise, the vocal cords close inappropriately or the supra-glottic structures adduct and narrow the airway[7].

An accurate diagnosis of EILO informs further treatment and management of the patient. A diagnosis alone may be reassuring for patients with EILO as it offers an explanation their symptoms[6]. They may go on to be offered speech therapy to help them to manage these symptoms. Patients with severe EILO who are unresponsive to standard therapies may be assessed for surgical intervention, commonly supraglottoplasty[7, 8].

Service Provision

Our department conducts more than 360 cardiopulmonary exercise tests (CPET) each year with referrals from respiratory, cardiology, vascular surgery, gastrointestinal and renal services. Anecdotally, we have noticed an increasing number of referrals from the respiratory team for the investigation of patients, with no evidence of asthma or other respiratory diseases, with unexplained dyspnoea on exertion. These patients tend to have normal lung function test results, negative responses to non-specific airway challenge using mannitol and negative EIB tests. During exercise testing some of these patients elicit symptoms typical of upper airway obstruction including stridor during exercise. We recognised that these patients may be experiencing EILO and, therefore, would be candidates for CLE testing.

Service Development

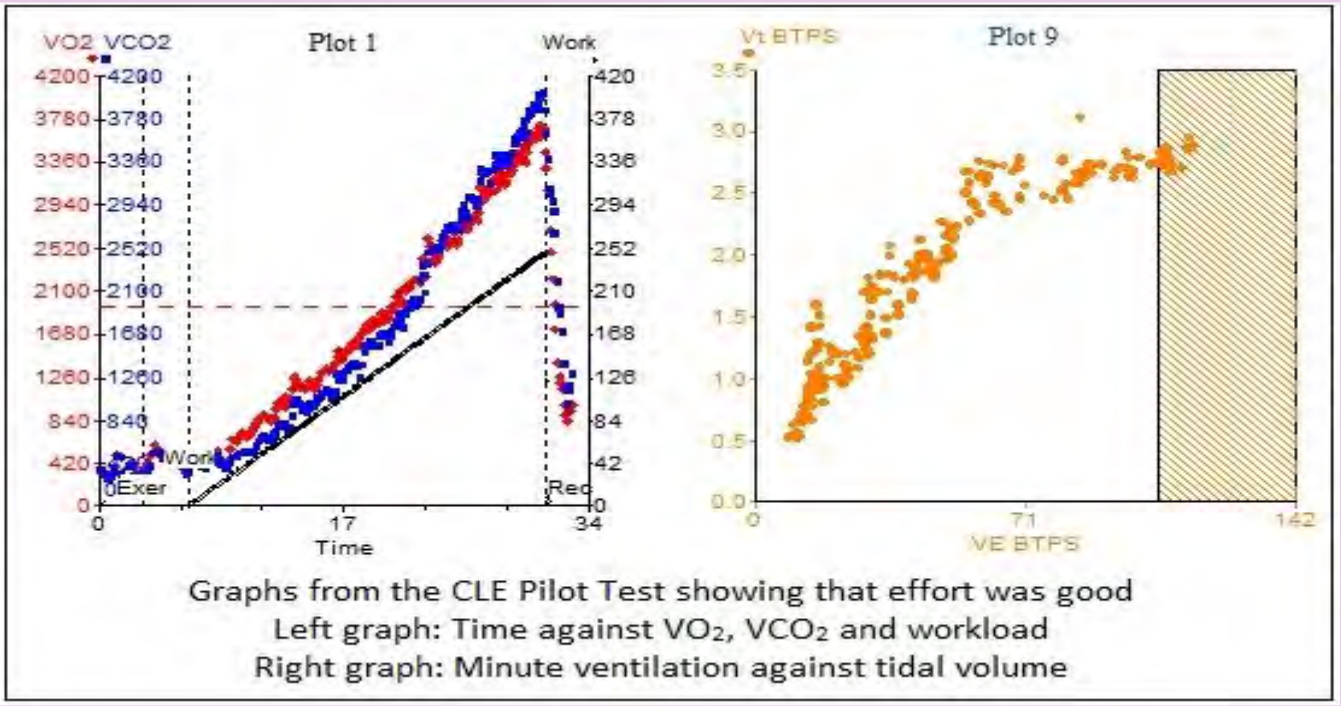
We invited our colleagues in the ear, nose and throat (ENT) department to work collaboratively to develop a CLE service. A consultant ENT surgeon with a special interest in upper airway abnormalities, who had recently joined our Trust, accepted the invitation. At an initial meeting we discussed the proposed new service and considered patient safety, equipment, staffing and facilities. We identified a suitable patient and made plans for a pilot test.

Initial Testing

Unfortunately, the patient did not attend the planned appointment but a member of staff volunteered to undertake the test. A laryngoscope was placed and held in the nasopharynx for the full duration of a symptom-limited incremental cycle ergometry test. Concurrent breath-by-breath respiratory gas analysis was successfully conducted. This pilot test allowed us to identify potential problems and consider possible solutions which could be implemented at the next test.

The laryngoscope is inserted through the nasal cavity and held in the nasopharynx. This can be uncomfortable and we discussed the use of a local anaesthetic spray to improve tolerance of the test. Improved tolerance must be balanced against the possible effect of local anaesthesia on the function of the laryngeal structures.

During CPET, the patient wears a snug-fitting mask over the nose and mouth in order for breath-by-breath analysis to be conducted. During the pilot test we found that a mask could be secured over the laryngoscope without causing leak. Our CPET SOP had to be suitably adapted to facilitate placing each piece of testing equipment in turn. As the laryngoscope itself must remain in a steady position during exercise, the operator needs to hold it or a device needs to be put in place to hold the instrument. The cycle ergometer needed to be positioned such that there was access to it from all angles as well as reasonable room for the laryngoscope operator to work next to the patient.



Graphs from the CLE Pilot Test showing that effort was good
Left graph: Time against VO_2, VCO_2 and workload
Right graph: Minute ventilation against tidal volume

As we looked to expand our CPET service to incorporate CLE we also considered how these tests should be funded (ie day case or by tariff) and how each test should be reported back to the referring consultant. As with any new service we

had to consider the impact of increasing patient numbers on our department. We will also needed to develop a specific CLE SOP, patient information letters and clinical reporting templates.

Service Development

Since the pilot test, we have undertaken a number of CLE tests with patients in the department. A business case for the development of the CPET service to incorporate CLE was accepted. This is now a fully commissioned service accepting referrals for patients with suspected EILO.

Conclusion

This work demonstrates the power of partnership working in developing our exercise service. The development of a commissioned CLE service enhances the diagnostic capability of our department and improves the quality of care that we can deliver to our patients. This could provide patients with suspected EILO with an accurate diagnosis without needing to travel long distances to other specialist centres and provide care and treatment closer to home. This local provision of a specialist service also saves costs by reducing the number of inter-service provider referrals. In these ways, the development of this service contributes towards the Trust's vision of becoming a world class national and international world class healthcare provider.

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Matt Rutter
Alan Moore
Brendan Cooper

ON THE BLOWER

This edition of 'On the blower' is focused on what was revealed at the conference. For more information click on the company name for access to their website.

Manufacturers Survey

Thank you to all those who responded to the survey, it was a vast improvement on last year and I hope we can do even better next year as the manufacturers do really value your feedback.

The award winners were:

Small diagnostics — Intermedical

Lung function — nSpire

Sleep Diagnostics — Resmed

Sleep Therapy — Resmed

Manufacturers special mentions — Shireen Elsworth

Best conference stand — Vitalograph

Survey Draw winner — Joanne Coutts

Well done to all the manufacturers

MR

Circassia

Circassia Ltd were delighted to be present at this year's ARTP conference demonstrating the NIOX VERO® device for FeNO measurement.

This provided delegates with the opportunity to see first-hand how the correct 50ml/s flow rate is the gold standard for measuring, and essential to delivering a validated result at the point of care.

Delegates having a go at performing their own measurement did so using the 10 second mode and were reassured that for children who are not able to perform the 10 second test, the 6 second mode is an alternative.

Feedback on the choice of 3 animations, and the ability to demonstrate each animation to the patient prior to measurement, was extremely positive.

Overall, ARTP members valued the single validated test, quality and reliability of result at the point of care which FeNO by NIOX offers.

It was also pleasing to see FeNO measurement positively presented during some of the presentations, which emphasised that a FeNO score is a "key part of the jigsaw puzzle" when diagnosing asthma.

We look forward to the next ARTP conference.

Fisher & Paykel

F&P SleepStyle™ Launch – ARTP 2018

Fisher & Paykel Healthcare Ltd were delighted to launch the new SleepStyle™ AUTO/CPAP device at ARTP 2018 in Brighton. SleepStyle™ has simplicity woven into its design and every detail has been considered to make CPAP therapy easy and comfortable.

The key features of the new F&P SleepStyle™ AUTO/CPAP device include:

1. User-friendly menu: In collaboration with our users, we created a simple menu. It is designed to save time in setting up the device, and to be easy to use and remember. F&P SleepStyle™ also carries the American Arthritis Foundation's Ease of Use Commendation. It has passed independent testing by experts, and evaluation by people with moderate-to-severe arthritis*.

2. Large and responsive buttons: The layout and function of the buttons work in harmony with the menu to allow quick navigation. Patients just need to push "Start".

3. Easy-access chamber: A simple push of the button gives access to the water chamber which is easy to fill and clean.

4. Quiet, integrated design: The power supply and humidifier have been integrated fully, to minimize space taken on the bedside table.

5. Built in connectivity options: Get information when you and your patients need it. A modem option ensures automated data transfer while **Bluetooth®** technology across all models enables patients to track their progress instantly using the SleepStyle™ App.

6. Powered by technology: We've done everything we can to help, from having a world-class auto algorithm with central apnoea detection, to providing a full range of innovative comfort options.

For more information on SleepStyle™, please contact your local F&P representative or contact our UK office on 01628 626 136.F&P SleepStyle Word Descriptions for 2017 Launch

**The Arthritis Foundation's Ease of Use Commendation recognizes products proven to make life easier for people who have arthritis and other physical limitations. Independently tested by experts and evaluated by people with arthritis, Ease of Use products are easy to use by everyone.*

ON THE BLOWER

Healthcare 21

Vivatmo *pro* – FeNO Measuring Device

Vivatmo *pro* is the first Healthcare product from Bosch Healthcare Solutions, distributed by Healthcare 21 in the UK and Ireland. Coming soon, Vivatmo *me* – the portable FeNO measuring device for GP and Home Use.

The most intuitive and maintenance -free FeNO measuring device for practices and clinics

Vivatmo pro was specially developed for professional use. Thanks to its simple measuring procedure and intuitive operation, it is optimized for integration into clinical routines. This means physicians can be more efficient in their everyday clinical work, enabling them to further improve personalised patient treatment. The Vivatmo pro device for physicians differs from the competition in that it is wireless, maintenance-free and is easier to operate.

Benefits of the Bosch FeNO measuring device

- Easy measurement thanks to intuitive user guidance and visual animation
- Results are available immediately following measurement
- Flexibility of use thanks to cordless measuring device and inductive charge management
- Optimum integration into practice workflows thanks to direct patient data collection, transfer via Vivatmo pro and connectivity to IT environment via HL7 or GDT interface
- Maintenance-free system: no calibration required during the unit's entire service life

http://www.healthcare21.eu/product/respiratory/airway-asthma-inflammation-management/vivatmo-pro-bosch-healthcare-solutions/

Intus Medical

IntusTrade.co.uk HEALTHCARE for NHS clinics and resellers

Provent Sleep Therapy is now available through Intus Healthcare.

Provent Therapy is a simple, non-invasive treatment for Obstructive Sleep Apnea (OSA). The Provent Nasal Device uses a valve design that attaches over the nostrils and is secured in place with hypoallergenic adhesive. The valve opens and closes, redirecting air through small holes to create resistance when breathing out. This resistance then creates the positive pressure in the airway typically provided by CPAP therapy.

It is intended for use by those who have been unable to maintain compliance with CPAP therapy; instead providing a comfortable alternative that is also discreet and convenient. Provent therefore provides clinicians with a plan-B for those patients who simply cannot tolerate or maintain acceptable compliance levels with CPAP.

It is a disposable, single-use device sold in monthly packs. Provent Sleep Therapy is CE and FDA approved, with numerous publications demonstrating its effectiveness in treating mild and moderate OSA.

Provent can also be purchased by patients directly from CPAP.co.uk/provent

Contact Intus Healthcare for more information – trade@intushealthcare.eu

Intermedical

Proud winners of the ARTP Small Manufacturer Of The Year Award 2018.

At this year's ARTP conference, Intermedical were showcasing products from their Cardio Respiratory and Sleep diagnosticx range.

The Easy One Prolab from ndd was demonstrated on the stand. It is a fully portable PFT system for spirometry, transfer factor and lung volume measurements including lung clearance index. It uses ultrasonic technology to measure flow, volumes and the molar mass of gases. It has been used in the following applications in the UK: outreach clinics, ward testing, for testing paediatric and adult CF (both clinically and for research) and for routine lung function testing in paediatrics and adults. The software is license-free and can be networked with hospital systems.

Also on display was the Resmon Pro, which is an oscillometry device that can detect peripheral airway disease missed by spirometry, from tidal breathing. It is currently being used in the UK in CF and paediatric applications and in a multi-centre trial by Chiesi.

From the sleep diagnostics range, the Medibyte was displayed. This is a sleep recorder for domiciliary use available in 6 and 12 channel versions. The device is robust and can be used with single-use pre-sized RIP belts. There is also a cloud service available for remote testing and diagnosis.

Intermedical's range of desktop and handheld spirometers including the ndd Easy on-PC and the brand NEW EasyOne Air were also on display. These devices use ultrasonic technology to measure x flow and volumes. The NEW EasyOne Air is a welcome addition to the range replacing the existing EasyOne and features a touch screen, Bluetooth, direct print options and is fully compatible with the licence-free EasyOne connect software. The MIR Intermedical Spirolab is a beautifully designed desktop spirometer specifically designed for use in the UK. It features a large 7-inch touchscreen and built in thermal printer. Spirometry PC software is also available with the Spirolab.

Intermedical also demonstrated the Bedfont NObreath. It is a highly accurate and reliable diagnostic FeNO monitor without the high running costs. The NObreath® is simple to use and is the perfect solution for cost-effective FeNO monitoring at only £3 per test.

nSpire

NSPIRE HEALTH

nSpire Health would like to thank all the attendees of the ARTP conference in Brighton for taking the time to visit our stand and also thank the labs who took the time to complete the manufacturers survey, it was a real honour to be presented with Manufacturer of the year award for 2018.

At the conference this year we were demonstrating our latest KoKo Px software and also had our new Iris Decision software on display.

We are excited to be releasing the next modules in the Iris Decision software range later in 2018 which will have valuable additional benefits for all respiratory labs.

Iris Decision allows the collection, validation and analysis of multi-source respiratory data from a single access point and when paired with our Iris Connect HL7 software it will allow a seamless connection with your hospital EMR.

So watch this space for more exciting releases in the coming months and in the meantime please do not hesitate to contact us regarding future business opportunities, service and consumable needs or if you just want a chat :)

ON THE BLOWER

Numed Healthcare

New Vertical Turbine Spirometer with Improved Low-Flow Sensitivity

SpiroConnect, an innovative new spirometer with vertically orientated turbine, was exhibited at the ARTP conference by Numed Healthcare. It is the latest generation of spirometer designed by Chris Lawson, inventor of the turbine spirometer in 1982, Micro Medical's Technical Director for 27 years and designer of the widely known MicroLab, MicroLoop and SpiroUSB over 10 years ago.

The benefits of turbine spirometers are well documented, particularly the excellent long-term calibration stability, regardless of changes in air temperature, pressure or humidity, or the presence of moisture from the patient's breath. However, poor sensitivity to low flow rates has often been reported.

Chris Lawson's new vertical turbine has all the benefits of his previous design, but in addition, it systematically overcomes the factors that limit the low-flow response of all other horizontally mounted turbines on the market (friction in the bearings, imbalance in the vane and static attraction between turbine housing and vane). As a result, SpiroConnect comfortably surpasses the ATS/ERS recommendations for low-flow sensitivity (0.025 L/s or 1.5 L/min), making it the perfect spirometer for testing patients with respiratory disease.

SpiroConnect is supplied exclusively through Numed Healthcare based in Sheffield. Numed specialise in the integration of diagnostic devices into the leading GP clinical systems (EMIS, SystmOne and Vision), making spirometry testing in the GP practice **safer** (results/reports are always filed to the patient's medical record correctly), **faster** (all data entry and filing of results/reports is done automatically saving up to 10 minutes administration time per test) **easier** (test workflow is dramatically simplified for the nursing team) and now, with the vertical turbine, **more accurate** too.

SpiroConnect can be used with a desktop or laptop computer, and there is also an App for use on an Android tablet or phone, which is perfect for domiciliary visits or testing on the hospital wards.

SpiroConnect has all of the features you would expect in a spirometer, including options to use GLI predicted values, ARTP test acceptance criteria and ARTP interpretation. You can visit the Numed Healthcare website www.numed.co.uk or call 0114 2433896 for more details.

PneumaCare

PneumaCare
THORACO-ABDOMINAL
DYNAMIC RESPIRATORY IMAGING

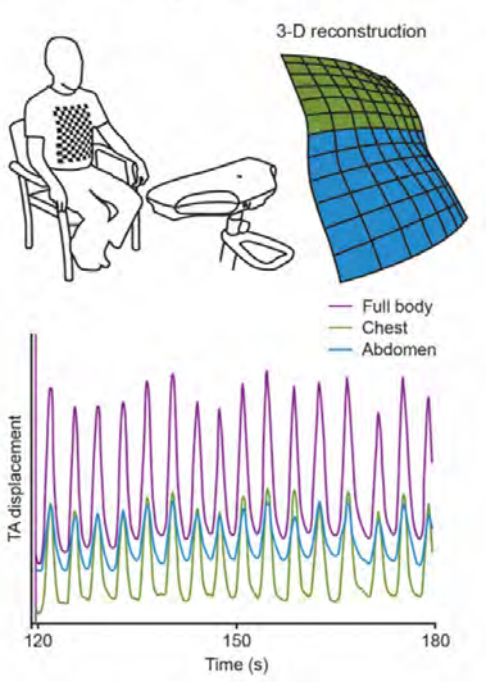
PneumaCare, non-contact respiratory motion measurement

PneumaCare is a Cambridgeshire (UK) based company providing clinicians with unique non-invasive ways of observing active, real-time regional respiratory function via chest wall movement. It provides the capability for clinicians to assess tidal respiratory function in all patients including previous inaccessible groups, whether young or old, conscious or unconscious, sitting or lying down; it requires minimal patient cooperation and its use does not require any contact with the patient.

PneumaCare's mission is to provide revolutionary imaging technologies that increase efficient and effective patient care with a vision of becoming the market leader in non-contact, non-invasive respiratory imaging technology.

Our SLP (Structured Light Plethysmography) technology – Thora-3Di – was presented at ARTP 2018. The technology in short is comprised of a structured grid of light that is projected onto a subject's chest and abdomen and two cameras that track changes in the grid pattern over time. This can provide a one dimensional signal corresponding to a subject's tidal breathing pattern. Regional displacement of different compartments (chest and abdomen, left and right hemi-thorax) can also be quantified and visualised. Using these regionalised signals one can then calculate regional tidal breathing parameters such as relative thoracic contribution and thoraco-abdominal asynchrony (TAA).

Figure 1. Working principle of SLP



Tidal breathing parameters extracted from tidal breathing patterns can serve as biomarkers which can subsequently be used for diagnosis, screening, monitoring and/ retraining of patients with various conditions.

PneumaCare website: http://www.pneumacare.com/

ON THE BLOWER

PARI Medical Ltd

PARI showcased their new respiratory diagnostic devices at the ARTP conference in Brighton

With well over 100 years' experience in respiratory solutions, PARI have introduced a new range which work together to give 'state-of-the-art' Asthma and COPD diagnosis.

Consisting of an easy-to-use PC spirometer for healthcare professionals, with the option of adding a mobile handheld device for patients to use at home, the **SpiroSense** solution enables both diagnosis and optimised treatment plans, based on comprehensive, serial patient data.

The professional spirometer – **SpiroSense*Pro*** - has intuitive, easy-to-use software enabling simple data transfer.

Modern, hot-wire technology for high measurement accuracy, even at low flow rates

Intuitive, easy-to-use software with simple data transfer

Automatic self-calibration removes need for calibration or annual servicing

Child-friendly animation helps patients with the correct breathing technique

New GLI* reference values included (for children from 3 years old)

NICE has recommended FeNO testing to help diagnose asthma in adults and children when diagnosis is unclear[1]. The Vivatmo FeNO testing solution offers a simple, maintenance-free option that can be added to the patient pathway.

Easy measurement thanks to intuitive user guidance and visual animation

Results are available immediately following the measurement

Cordless/tubeless measuring device and inductive charging

Maintenance-free system: no calibration required

Effortless data and patient management directly via the touch screen

For further information or a demonstration

PARI Medical Ltd Email: infouk@pari.eu Tel: 01932 341122 www.pari.com/spirometry

[1]*NICE Guideline Asthma diagnosis and monitoring*

**GLI = Global Lung Function Initiative*

RemServe

RemServe Medical Supplies are excited to announce that we are now working with ResVent Medical in introducing their medical devices to the market and particularly with their new “iBreeze” series which is available for CPAP, APAP and BiPAP. We genuinely believe that these machines can breathe new life in to field with their attention to detail as well as innovative features and a sleek design.

Quoted as “Smart. Comfortable. Quiet” it’s easy to see that they have spent a lot of time perfecting their product line with the integrated humidifier being an excellent feature especially when considering the size and general aesthetics of the devices. A great feature of humidifier is its ability to actively monitor the water level and once emptied it will deactivate without any interaction from the patient/user.

As well as the humidifier, the iBreeze series also features a 5.0’ inch touch screen panel on the BPAP model which makes navigating the basic menu system a breeze whilst also including a menu dial (both CPAP and BPAP) for traditional access, there is also Bluetooth functionality which allows access and control of the device via Bluetooth enabled smart devices.

ResVent have also developed a great piece of software (“iMatrix”) which can be accessed by patients and clinicians to allow easy access to data collected from the device which can be held on a cloud data server as well as the option to store it on an SD Card. This information can be accessed via an app available for tablets/smart devices as well as on desktop PCs/laptops.

ON THE BLOWER

S-Med

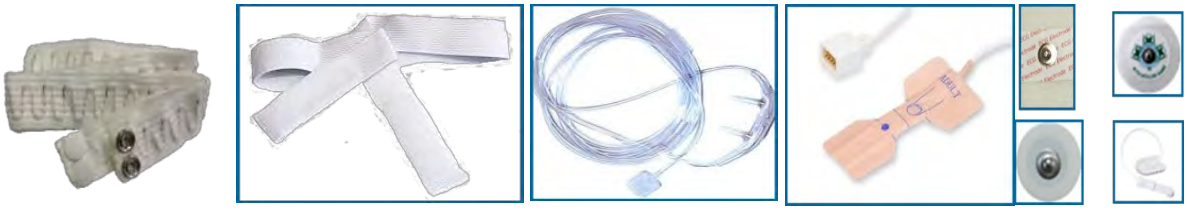
Somnomedics have released a new version of DOMINOlight, V1.50 which includes some important new features:

Automatic update of DOMINO light software and SOMNOtouch firmware via the internet
Support of new sensors such as the new 4-channel analogue Optocoupler
Automatic RERA-detection
Differentiation between snoring and breath sounds in Snore Analysis
Set Makers with user-defined key combinations
Additional values in the PAP report table

Hardware Updates: SOMNOtouch EEG Headbox

Somnomedics have released a new version of the EEG headbox for the Somnotouch, the threshold for visual impedance check via green/red LEDs on the headbox is now set to 5 kOhm. The LEDs will be red if the impedance is higher than 5 kOhm indicating that the electrode positioning needs to be improved at the corresponding electrode positions.

We have extended our range of low-cost disposable accessories available for all sleep equipment and now have available:
Disposable RIP Effort belts for all ages
Disposable Standard (non-rip) Effort belts for all ages
Disposable Nasal Cannula and our NEW Nasal/Oral Cannula
Disposable SpO2 probes
Disposable ECG and EMG Electrodes



Sensors Updates:

SOMNOmedics now offer a new IC-EMG (intercostal EMG) Sensor - a direct effort signal from the diaphragm, this can be used to differentiate differences between Respiratory insufficiency and Inspiratory muscle dysfunction displaying the true effort curve signal within the RAW Data synchronised to the traditional effort signals. This can Help to diagnose increased airway resistance, reduced breathing effort e.g. due to obesity, a decrease in the area of the lung available for gas exchange or neuromuscular problems This sensor is now available across the range of SOMNOmedics sleep diagnostic equipment.

ON THE BLOWER

Vitalograph®
Your cardio-respiratory partner
Data you can rely on.
People you can trust.

ARTP Conference a Resounding Success for Vitalograph

Vitalograph would like to thank the members of the ARTP for another rewarding and enjoyable conference. Our stand was very well attended and attracted very positive feedback, resulting in it being voted best stand.

Low Running Costs, Optimal Hygiene

Our key message at the conference was to highlight the low running costs and optimal hygiene delivered by the new micro handheld spirometer and the Pneumotrac PC-based spirometer with HL7 connectivity. All Vitalograph spirometers are supplied with the latest GLI predicted equations to ensure they meet national and international recommendations.

New ECO BVF

In line with our core message of low running costs and optimal hygiene, our showcase product at conference was our new Eco BVF (Bacterial Viral Filter).This new BVF has strong economic and ecological credentials. As well as being eco-friendly and recyclable these new BVFs deliver outstanding protection against cross-contamination at a great value price.

- Validated cross-contamination efficiency of >99.999%
- Available as single filter packs or PFT packs with disposable nose clip
- Filter and nose clips made from 100% recyclable materials
- Versions available to fit devices from all leading PFT manufacturers
- Vitalograph have a BVF to fit all leading manufacturers of PFT equipment.

The Eco BVFs are the first of a number of new products scheduled to be added to the Vitalograph range in 2018.

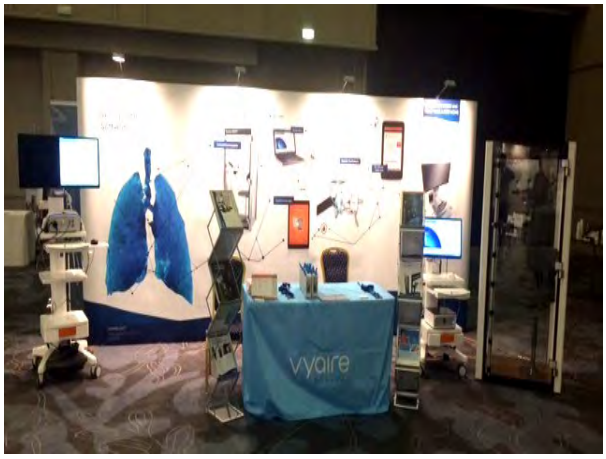
Competition Winner

Emily Maxwell, trainee Clinical Scientist at Churchill Hospital, winner of our Eco BVF competition, being presented with an Apple iPad by Adrian Fineberg, Vice President UK Sales and Service. ‘Thanks for holding a great stall at the ARTP conference this year’ said Emily. ‘It was great to meet the faces behind our suppliers, and have a go at the competition for the iPad. Never thought I’d actually win! I’ve always wanted one, and it’ll definitely come in useful with my training programme. Thanks Vitalograph!’

ON THE BLOWER

Vyaire

We would like to start again by saying thank you to all of those who attended our workshops and visited us at the recent ARTP in Brighton. The workshops were well attended and the feedback has been very positive, and it was great to see everyone, so thank you.



The ARTP Brighton 2018 was another fantastic opportunity for Vyaire Medical to showcase our latest Vyntus product line complemented by our full connectivity solutions. Our Vyntus BODY and Vyntus CPX continues to be well received by all those who test on the systems, which has been extremely satisfying.

We had many team members supporting the event including our International colleagues (Margriet, Rob and Herman), demonstrating the passion and commitment we have to the ARTP and for the respiratory industry.

I mentioned in the previous "OTB" that we would have our new training centre up and running in December, and I please to confirm that this facility is now fully operational. The feedback from those who have visited us already has been excellent and also from those who plan to visit us soon. We would welcome everyone to come along and learn about our various products and connectivity solutions, whether you are an existing/prospective user or simply one with a keen interest in what latest technology we have to offer. We have made a significant investment in our training centre, which we feel goes someway to support all our customers and ultimately the patients that you serve.

With the move to our new Training Centre, please note our direct office numbers have changed to **01256 976524 or 01256 976525**.

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Improving Patient Outcomes, and Increasing Value for our Customers.

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BOC Healthcare

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Stowood

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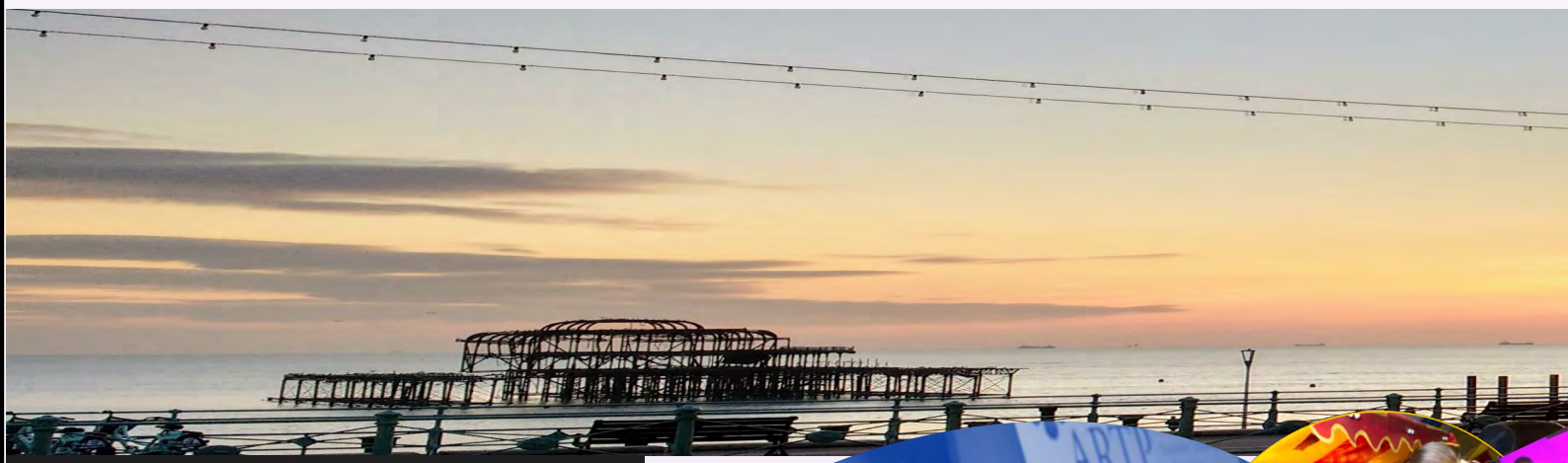

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ARTP Conference 2018

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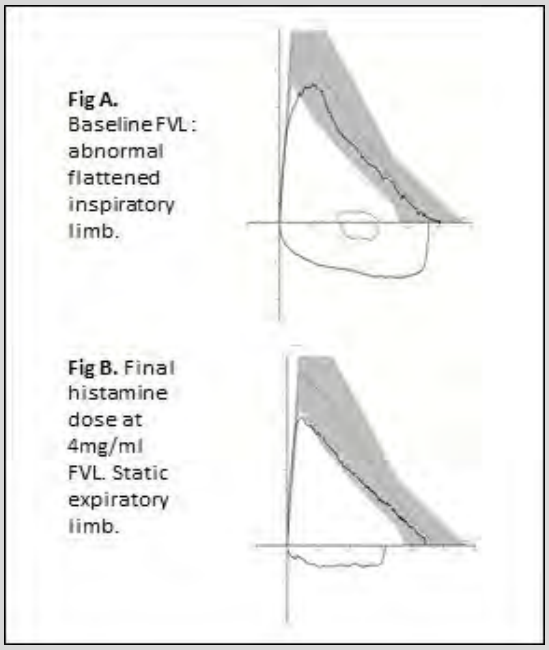
O1 CASE REPORT: THE WHEEZY WHEELER

Anna Donaldson, Harry Griffin and Helen Purcell
Hampshire Hospitals NHS Foundation Trust

Introduction: A 41 y old man previously diagnosed with asthma was referred to the chest clinic with worsening exercise ability and breathlessness. The patient was a keen cyclist and he noticed 'very noisy' breathing and a wheeze when he was exercising at maximum. Inhaled medication had not helped. His past medical history included surgical closure of a patent ductus arteriosus (PDA) aged 5.

Results: Baseline pulmonary function tests (PFTs) (Table 1) were within normal limits other than an abnormal inspiratory limb (Fig. A) of the flow volume loop (FVL) with an MIF_{50}/MEF_{50} ratio pre- histamine challenge of 0.696 (MIF_{50} =2.52 L/s and MEF_{50} =3.62 L/s). A ratio <1 suggests extra-thoracic airway obstruction. His histamine test demonstrated no change in the expiratory portion of the FVL and no change in FEV_1 as the histamine dose was increased (Fig. B). The test demonstrated a significantly reduced inspiratory limb throughout and the patient experienced similar symptoms to when he exercised with stridor.

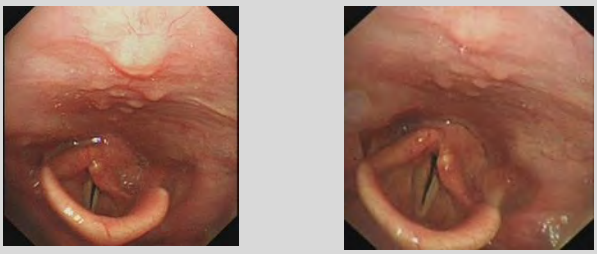
	result	% pred	SR
FEV1 (L)	3.82	98.3	-0.13
FVC (L)	5.01	106	0.46
FEV1% FVC	76.24	95.5	-0.5
VC MAX (L)	5.01	101.6	0.14
PEF (L/S)	7.24	78.7	-1.62
TLC (L)	6.55	95.2	-0.48
RV (L)	1.57	79.3	-1.00
VC (L)	5.08	102.9	0.25
FRCpleth (L)	2.89	85.1	-0.85
IC (L)	3.76	105.8	
ERV (L)	1.32	93.1	
TLCO_SB mmol (min*kPa)	11.17	103.2	0.25
VA single breath	6.35	93	
KCO_SB mmol (min*kPa*L)	1.76	113.4	0.81



From the PFT results it was thought he could have possible exercise induced laryngeal obstruction (ILO) or vocal cord dysfunction. He had a normal CT chest. Fibre-optic bronchoscopy (Fig. C.) showed that the left vocal cord (VC) was paralysed and the right VC only had very limited movement. His glottis opened only to approximately 3 mm.

Fig. C. Bronchoscopy images showing left VC palsy (lying in the midline with no movement) and limited movement of the right VC, lying in the paramedian position.

(i) Image at rest (ii) Image during



Conclusions: It is unusual for a patient to present in adulthood with VC palsy presumed secondary to left recurrent laryngeal nerve damage that occurred during the surgical closure of a PDA as a child. It is an accepted peri-operative complication, with a reported incidence between 1.7-67%[1]. This patient was referred to ENT for further assessment and possible intervention. It is thought his right VC problems might be due to arytenoid fixation. The abnormal inspiratory FVL and symptoms during his histamine test pointed towards an upper airway problem and guided investigations. He still cycles 100miles/week.

References

1. Recurrent laryngeal nerve injury during PDA ligation: can this common complication be reduced? Editorial. J. Perinatology (2010) 30, 371-372

O2 HYPOXIC CHALLENGE TESTING IN THE UK

H.S. Griffin and H.L. Purcell
Hampshire Hospitals NHS Foundation Trust

Background: A continued rise in the popularity of air travel and an ageing population has resulted in significantly more patients with respiratory disease flying. Hypoxic challenge tests (HCT) are the most reliable method of determining the probability of experiencing significant hypoxaemia. In contrast to other lung function tests, there are only limited guidelines for the performance of HCTs and thus we hypothesised there would be a significant variation between departments in the UK.

Method: Attendees of the 2017 ARTP conference and members of the ARTP Forum were invited to complete a survey. If ≥2 departments from the same NHS trust shared a HCT protocol only one response was included in the analyses. Results shown are only for adult NHS services.

Results: Of the 59 departments performing 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. 81.4 % (48) used the Venturi mask method, 16.9 % (10) used a pre-made hypoxic gas mixture with a mask, or 5.1 % (3) with a mouth piece. Only 1.7 % (1) used the body plethysmography method. 80.0 % (46) took a blood gas as part of the standard protocol and 88.1 % (52) provided supplemental O_2, of which 21.2 % (11) offered only 2 L/min and 78.8 % (41) offered 2 and 4 L/min.

Conclusions: In this sample of NHS departments the majority offer HCTs on the NHS and use the Venturi method. Furthermore, most departments routinely take a blood gas and offer supplemental O_2. However, it should be considered that patients are likely to remove their in-flight supplemental O_2 when mobilising which could exacerbate any exercise-induced hypoxaemia. Future research is required to determine whether HCT protocols should assess the effects of exercise during low inspired O_2 conditions. Furthermore, with concentrators and conserver devices now being used in-flight, the current guidance on assessing and recommending specific flow rates of supplemental O_2 may need revising.

O3 PILOT DATA OF THE SHORT-TERM EFFECTS OF E-CIGARETTE (EC) VAPING ON LUNG FUNCTION

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Introduction: EC manufacture, advertisement, sales and use are not restricted (apart from Wales). The health effects of EC are unclear, although data suggests inhalants are associated with inflammation, altered gene expression and cell death. This is a pilot study to assess acute changes in lung physiology in healthy volunteers following EC use.

Materials & Methods: 10 healthy EC users were recruited (non-smokers). Baseline lung function included oximetry, forced oscillometry (FOT), exhaled nitric oxide (F_eNO), exhaled carbon monoxide (COHb),spirometry, gas transfer and plethysmography (volumes and resistance). Participants then vaped for 5 minutes. Selected lung function was repeated at 5, 10, 30 and 60 minutes post-vape. All ECs contained nicotine and the dose was estimated by weighing pre- and post-vape. Data was compared using a Friedman test, except for COHb (only measured at baseline and 60 minutes), which was compared using a Wlicoxon Signed-Rank test.

Results: Spirometry, plethysmography, gas transfer, F_eNO and oximetry did not change over the time course. Significant differences in Inspiratory Resistance at 5Hz (R5IN) % predicted by FOT were noted from baseline (median 89.1, IQR 71.3-99.0) to 5 minutes (median 109.2, IQR 92.8-121.0)($p<0.001$) and 10 minutes (median 99.9, IQR 96.6-115.5)($p<0.01$) post-vape. COHb increased in every patient from baseline (median 1.5, IQR 0.0-2.0) to 60 minutes post-vape (median 24.0, IQR 16.8-28.0) ($p<0.0001$). There was no nicotine dose-response with the changes in lung function.

Conclusions: ECs appeared to increase airway resistance. However, this change could be attributed to baseline lung function performance or deep inhalations during vaping. The increase in COHb is surprising as it is more than would be expected from repeat T_LCO measurements and there is no evidence that EC vaping produces CO.

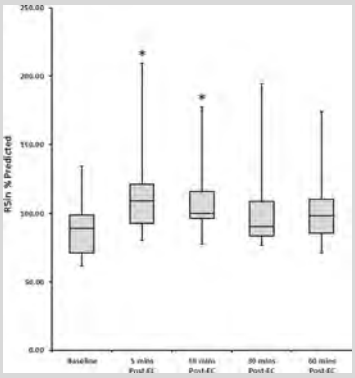

Figure 1: The change in $R5_{IN}$ % Predicted in healthy subjects before and at various time points after EC use (n=10) (*p<0.05).

O4 PRIMARY CILIARY DYSKINESIA DUE TO MICROTUBULAR DEFECTS IS ASSOCIATED WITH WORSE LUNG CLEARANCE INDEX

S Irving[1,2], M Dixon[1], MR Fassad[3,4], E Frost[1,2], J Hayward [3,5], K Kilpin[2], S Ollosson[2], A Onoufriadis[6], MP Patel[3], J Scully[3], SB Carr[2], HM Mitchison[3], MR Loebinger[2], C Hogg[2], A Shoemark[1,2,7], A Bush[1,2]

1 National Heart and Lung Institute, Imperial College London, London, UK;2 Royal Brompton & Harefield NHS Trust, London, UK; 3 Genetics and Genomic Medicine, University College London (UCL) Great Ormond Street Institute of Child Health, London, UK; 4 Human Genetics Department, Medical Research Institute, Alexandria University, Egypt; 5 Regional Molecular Genetics Laboratory, Great Ormond Street Hospital for Children NHS Foundation Trust, London, UK; 6 Department of Medical and Molecular Genetics, Division of Genetics and Molecular Medicine, King's College London School of Medicine, Guy's Hospital, London, UK; 7 Division of Molecular and Clinical Medicine, University of Dundee, Dundee, UK

Aims: Primary ciliary dyskinesia (PCD) is characterised by repeated upper and lower respiratory tract infections, neutrophilic airway inflammation and obstructive airway disease. Different ultrastructural ciliary defects may affect lung function decline to different degrees[1]. Lung clearance index (LCI) is a marker of ventilation inhomogeneity that is raised in some but not all patients with PCD[2]. Our aim was to detect possible differences in ventilation inhomogeneity between groups of patients with different ultrastructure defects in PCD.

Methods: Spirometry and multiple breath washout (MBW) were carried out on the same occasion by 69 stable patients with confirmed PCD. LCI was calculated from MBW. Age at testing, age at diagnosis, ethnicity, ciliary ultrastructure, genetic screening result and any growth of Pseudomonas aeruginosa was recorded. REC approval was obtained (10/H1101/69).

Results: LCI was more abnormal in PCD patients with microtubular defects (median 10.24, range 7.8-14.1) than those with dynein arm defects (median 8.3, range 5.8-14.9, p=0.004 Mann- Whitney test) or normal ultrastructure (median 7.63, range 6.2-11.8, p=0.0004 Mann- Whitney test). Age is correlated with LCI, with older patients having worse LCI values (p=0.03, r=0.3).

Conclusions: This study shows that cilia microtubular defects are associated with worse LCI in PCD than dynein arm defects or normal ultrastructure. The patient's age at testing is also associated with a higher LCI. Patients at greater risk of obstructive lung disease should be considered for more aggressive management. Differences between patient groups may potentially open avenues for novel treatments.

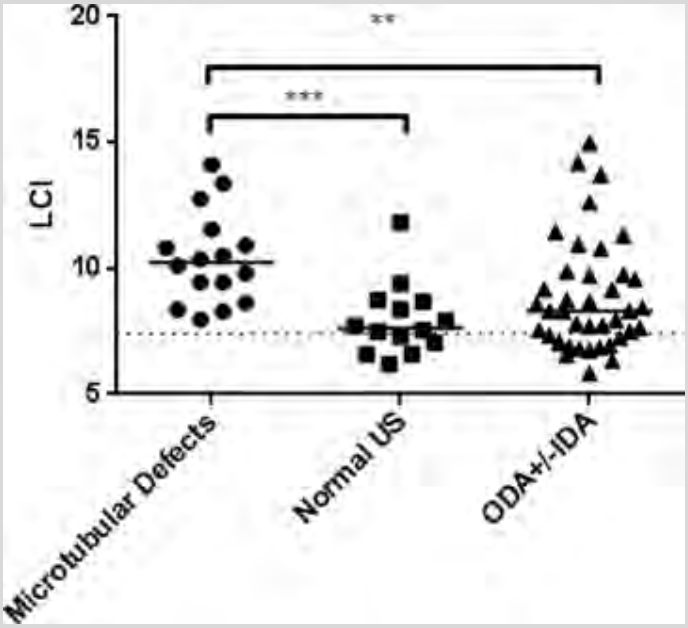

Figure – differences in LCI result between the ultrastructure defect groups. Patients with microtubular defects have worse LCI than those with normal ultrastructure or dynein arm defects

References

1. Clinical features of childhood primary ciliary dyskinesia by genotype and ultrastructural phenotype Davis SD et al, AJRCCM 2015 Feb 1;191(3):316-24

2. Lung clearance index and high-resolution computed tomography scores in primary ciliary dyskinesia. Irving S et al, AJRCCM 2013 Sep 1;188(5):545-9

TP1 CHANGES IN FVC WHEN USING ECCS REFERENCE EQUATIONS, COMPARED TO GLI EQUATIONS AND THE EFFECT IT COULD HAVE ON THE ELIGIBITY CRITERIA FOR PIRFENIDONE IN PATIENTS WITH IDIOPATHIC PULMONARY FIBROSIS

G Cramp. University Hospitals Coventry and Warwickshire

Introduction: Idiopathic Pulmonary Fibrosis (IPF) causes scarring of the lung tissue resulting in a range of respiratory symptoms. ERS/ATS guidelines state patients should be regularly monitored for disease progression. Antifibrotic drugs such as Pirfenidone and Nintedanib are common in treating IPF. NICE guidelines recommend Antifibrotic drugs only if a patient has an FVC between 50%-80% predicted.

The reference equations used in our service were European community for coal and steel (ECCS) (1993). In 2012 the new Global Lung Initiative (GLI) reference equations were published and implemented within our service in 2015.

Aims: The aim of this study is to identify if the difference in FVC %predicted by using ECCS and GLI could affect the eligibility criteria for Antifibrotic drugs.

Methods: Patients who attended the department for spirometry and subsequently went on to be prescribed Antifibrotic drugs were reviewed. FVC %predicted was obtained from the department's lung function equipment. Details of the patient's Antifibrotic therapy were collected from the patient's electronic hospital records. Paired sample t-test was used to identify any statistical difference.

Results: There was a statistically significant difference between the ECCS FVC %predicted and GLI FVC %predicted (p=0.0001). The mean FVC %predicted using GLI was less than the FVC %predicted using ECCS. This resulted in a 13% false negative rate and 1% false positive rate. Patient demographics are shown in Table 1.

Conclusion: This study shows that the difference between GLI and ECCS FVC %predicted can affect patient outcomes. When using GLI more IPF patients with milder disease meet eligibility criteria for Antifibrotic therapy compared to ECCS and therefore have a greater accessibility to treatment. This study also highlights the importance of both national and international standardisation of reference equations, particularly the use of GLI.

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2. NICE (2013) Pirfenidone for treating idiopathic pulmonary fibrosis, received 13th October 2016 from, https://www.nice.org.uk/guidance/ta282/chapter/1-Guidance
3. Europen Respiratory Society (ERS) (2012) Global Lung Function Initiative, received 13th October 2016 from, http://www.ers-education.org/guidelines/global-lung-function-initiative.aspx

	N = 92 (SD)
Ethnicity	22.82% (Asian) 77.17% (Caucasian)
Smokers	62.7%
Height (cm)	166.25 (+/-27.7)
Weight (kg)	77.5 (+/-18.5)
Gender (M)	70%
FVC (L)	2.152 (+/- 17.72)
ECCS FVC % Pre-	70 (+/- 13.55)
GLI FVC % Predict-	65.5 (+/- 12.65)

Table 1: Patient demographics

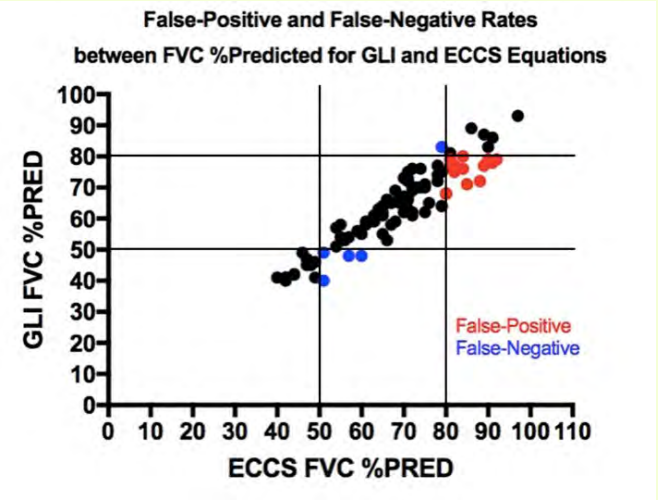

Figure 1

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TP2 COMPARISON OF METHODS FOR INTERPRETING BRONCHODILATOR RESPONSE IN CHILDREN

Raywood E, [1,2] Rees, S.[1] Fettes F [1] & Laverty A [1]

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2 RCCA, III, UCL Institute of Child Health, London

Introduction: Bronchodilator response (BDR) of FEV_1 is used to assess reversibility of airflow obstruction and expressed using several methods however there is no consensus on which is optimal and what denotes significant response in paediatric patients. Quanjer[1] using % change of FEV_1 predicted, suggested 9-12% change to classify moderate response or >12% as positive. A desirable method for paediatrics would be unrelated to age, height or baseline FEV_1 and using % change of FEV_1 predicted has been recently validated in adults[2].

Aim: To assess if using % change of FEV_1 predicted changed the classification of significant or non-significant BDR in our paediatric population.

Method: Retrospective retrieval of BDR tests performed between Jul-Aug 2017 and recalculation of bronchodilator response by two methods: 1) Percentage of initial Pre-Bronchodilator value (%Initial) and 2) Percentage of predicted (%Pred). The GLI-20123 reference values were used[3].

Results: 45 results were collected. A Wilcoxon test showed a significant difference between the two methods ($p<0.00$, Figure 1). To ascertain if this was a clinically significant difference, the plot showed good correlation between methods at <12% BDR ($r2=0.92$) but %Initial overestimated compared to %Pred at high BDR. Most children had a non-significant response (<12% change indicated by black lines; %initial n=34; %predicted n=37). Using 9% change for %Pred reversibility (Fig.1, grey line) 7 children not identified by the %Initial 12% cut off showed moderate BDR.

Conclusions: At high values of BDR the methods are significantly different. The %initial may be more relevant in children as it considers reference values. As the data collected had mainly a non-significant BDR further data collection is required.

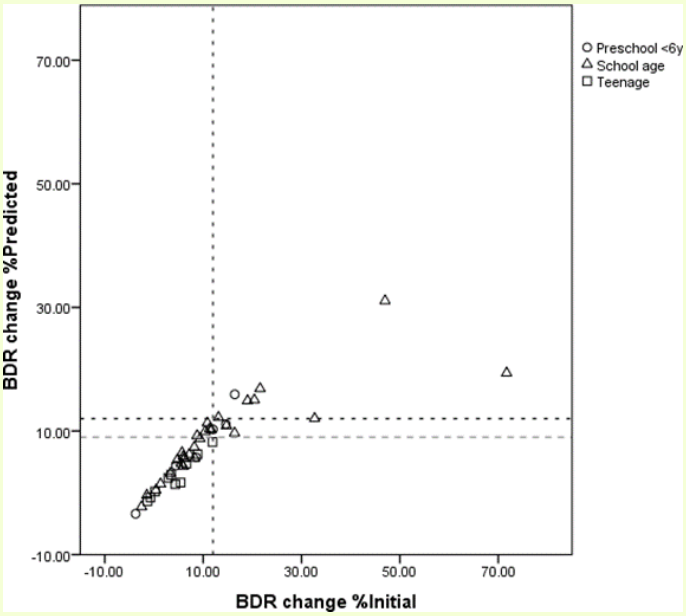

Figure 1 Correlation plot of BDR change as %Initial vs %Pred. Blacklines at 12% indicate significant change and Grey line at 9% for a moderate response. Categorised by age groups

References:

1. Quanjer et al. Eur Respir J Suppl, 1993, 16:5-40
2. Ward et al., Chest. 2015 148(4):877-886
3. Quanjer et al. Eur Respir J, 2012 40 (6):1324-1343

TP3 FACTORS ASSOCIATED WITH INCREASED MORTALITY IN ADVANCED COPD.

A Rathbone, Addenbrooke's Hospital , Cambridge

Introduction: An increase in severity of COPD is associated with an increased risk of mortality[1]. The Cambridge COPD unit receives regional referrals to consider lung volume reduction (LVR) in patients with advanced COPD. This study aims to determine if there are specific markers associated with mortality in this population.

Methods: Data was retrospectively analysed in 120 consecutive patients referred to the Cambridge COPD unit from January 2015 – January 2016. As of June 2017, which represented an 18-32 month window after referral, patients were categorised into alive and deceased groups. A total of 20 patients were deceased, which included 3 out of 20 that proceeded to LVR intervention. Full lung function, 6 minute walk, quality of life questionnaires and BODE which are routinely collected, was then compared for groups of alive and deceased patients. Data was analysed using IBM SPSS statistics v.24. A Mann-Whitney U test was performed to assess for differences between groups, with data displayed as median and interquartile range.

Results: The group of patients that were deceased 18 -32 months after referral were significantly more impaired across several variables, including; V_A/TLC, T_LCO, 6 minute walk distance and oxygen desaturation during the 6 minute walk test.

Conclusion: In advanced COPD; T_LCO, 6 minute walk data and V_A/TLC are specific markers that show a better association with mortality than FEV_1 (forced expiratory volume in 1 second) and BODE (body-mass, airflow obstruction, dyspnoea, and exercise capacity index).

References:

1 Rabe KF, Hurd S, Anzueto A, et al. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease: GOLD executive summary. Am J Respir Crit Care Med 2007; 176:532-55.

	Alive			Deceased			P Value	Effect size
	Number	Median	IQR	Number	Median	IQR		
V_A/TLC	56	64.68	16.79	8	53.28	11.67	**.028**	.27
T_LCO (% predicted)	94	37.0	16.1	17	29.2	12	**.005**	.26
6MWD (m)	83	241	152	14	200	154	**.027**	.22
DSP	58	216	129	9	170	131	**.039**	.25
Minimum S_pO_2 (%)	58	87	5	9	84	5	**.008**	.33
ΔS_pO_2 (%)	58	7	6	9	10	4	**.009**	.32

Table 1 Summary of significant differences between groups, presented as median and interquartile range (IQR). *V_A = alveolar volume, TLC*

= total lung capacity. T_LCO = carbon monoxide transfer factor. 6MWD = 6 minute walk distance. DSP = distance saturation product (6MWD(min spO2/100). minimum spO2% = 6MW minimum oxygen saturation. Δspo2% = resting spO2–minimum spO2 during 6MW).*

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TP4 FIXED FEV_1/FVC RATIO MISCLASSIFIES AIRFLOW OBSTRUCTION IN A DRUG DEPENDENT POPULATION

Maines, P. ; Peat, R. ; Furlong, J. ; Price, D. ; Russell, D.; Burhan, H. ; Oelbaum, S. ; Walker, P.P. Liverpool Heart & Chest Hospital United Kingdom; Royal Liverpool University Hospital United Kingdom University Hospital Aintree, Liverpool United Kingdom

Introduction: COPD is characterised by non-reversible airflow obstruction, which may present at an earlier age in heroin smokers. A population of 807 heroin smokers prescribed opiate substitution therapy were screened for COPD in line with local protocols; defining airflow obstruction using a fixed threshold of <0.7. It is known that using a fixed threshold risks underestimating airflow obstruction in younger individuals (false negatives) and overestimating it in older people. This can be overcome by defining airflow obstruction using lower limit of normal (LLN) for that individual.

Aim Reanalyse spirometry results using LLN in a drug dependent population to assess the misclassification of COPD.

Method Spirometry results for 807 pts were recalculated using lower limit of normal calculations. Mean Age 47.4 SD6.59. False negatives (percentage against normal) - Male 16 (8%) and female 17 (17%) Further to this, paired T-testing was used to analyse the mean MRC and CAT in subjects with mild COPD, Normal, False negative groups.

Results 33 false negatives were identified when using LLN, of which 16 (8%) were male and 17 (17%) female. Mean MRC and CAT score were positive in all groups with significant difference between normal and mild categories, false negatives fell between both groups but displayed no statistically significant difference. False negatives have the lowest mean age but no other significant differences were found in other demographics of the cohort

Conclusion Using LLN to establish airflow obstruction resulted in an additional 33 subjects who had a FEV_1/FVC ratio of 0.7 or greater being diagnosed with airflow obstruction/COPD. Of these subjects 17 were men and 16 were women which equates to a false negative rate of 8% in men and 16% in women suggesting females are more likely to misclassified as a false negative in this population.

TP5 RISK FACTORS ASSOCIATED WITH AN ACUTE EXACERBATION OF COPD (AECOPD), PREDICTORS OF 30 DAY READMISSION

Hurst, CA; Cliff, IJ; Respiratory Physiology Department, Royal Stoke University Hospital, Newcastle-under-Lyme.

Background: COPD is the second most common cause of emergency admission to hospital and the fifth largest cause for readmission[1], as a result there is significant interest in identifying factors that contribute to readmission risk. This exploratory analysis aimed to determine the 30 day all-cause non-elective readmission rate in patients previously admitted with an AECOPD and to identify factors associated with an increased risk of readmission.

Methods: Patients admitted with an AECOPD between October 2016 and January 2017 were included in the study. Sixty-four index admission variables were retrospectively collated and subsequent hospital database analysis was used to identify readmissions. Statistical analysis was performed using Student t-test, Mann-Whitney U test and $\chi 2$ test as appropriate. Logistic regression was performed to assess the association between predictor variables and all-cause 30 day readmission.

Results: Seventy-one patients admitted with an AECOPD were identified. Baseline characteristics of the cohort are shown in the table below.

During the study 35.2% patients were readmitted within 30 days of discharge with a mean LOS of 6.68±5.72 days and an average time to readmission 12.9 days. LOS, total number of admissions in the last 12 months and mobility level were entered into binary logistic regression analysis. The overall fit of the model was good and explained 36.8-51.6% of the variance in 30 day readmission group membership. Inclusion of the predictors significantly improved correct classification of group membership compared to the constant ($\chi 2(3) = 26.118$, $p<.001$). The model was better at correctly classifying those not readmitted than those readmitted.

Conclusion: Thirty day readmission rates following an AECOPD over a seven month period was high at 35.2%. Despite evaluating a wide range of potential predictors of 30 day readmission risk only two variables (LOS and mobility) remained significant within the model.

Reference:

1. Price, L. C. et al. Thorax 2006, 61(10) pp. 837-842.

Variable	All	30 Day Readmission		P-Value[a]
		Yes	No	
Total	71 (100)	25 (35.2)	45 (63.4)	-
Gender				
Male	31 (43.7)	11 (44.0)	19 (42.2)	.885
Female	40 (56.3)	14 (56.0)	26 (57.8)	
Age (years)	70.93±9.13	71.80±10.35	70.31±8.51	.519
Pack Years	43.83±23.59	44.39±21.17	44.26±23.41	.811
Total # Comorbidities	1.61±1.49	1.56±1.71	1.67±1.37	.408
Length of Stay (LOS) (days)	4.48±4.86	6.68±5.72	3.18±3.87	**.001**
Total # of Admissions in last 12 months	2.75±2.68	3.86±3.66	2.21±1.87	**.026**
MRC Dyspnoea Score†	4.05±1.04	4.53±0.64	3.73±1.16	**.024**
MRADL Questionnaire†	9.69±6.33	5.76±4.89	11.96±6.04	**.001**
Clinical Frailty Scale†	4.68±1.25	5.40±1.06	4.24±1.14	**.007**
Mobility				
Limitations in Mobility	30 (42.3)	16 (64.0)	14 (21.1)	**.003**
Fully Mobile	33 (46.5)	6 (24.0)	27 (60.0)	
CO_2 Retention†				
No	33 (46.5)	7(28.0)	26 (57.8)	**.041**
Yes	13 (18.3)	7(28.0)	6 (13.3)	

Data are number of patients (%) or mean ± standard deviation, P-values are from chi-square tests or Fisher's Exact Test and independent t tests/non-parametric equivalent or Mann Whitney-U. †Variables with greater than 20% missing data. . A *p* value of <.05 was considered statistically significant.

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TP6 WOLFF-PARKINSON-WHITE SYNDROME PRESENTING AS SEVERE ASTHMA.

Shakespeare, J. ; Fielding, R. ; Osman, F. ; Gelder, C.
UHCW NHS Trust United Kingdom ;

Department of Respiratory Physiology and Sleep United Kingdom ; Department of Cardiology United Kingdom

Introduction: We report the case of a 16-year-old female suspected of and treated for severe, acute, life threatening asthma. She presented with sudden onset breathlessness and wheeze, which deteriorated following admission resulting in respiratory failure. She was subsequently intubated and treated in ITU. Following discharge she underwent outpatient assessment of her asthma. Results of spirometry were normal with an FEV_1 4.05L (2.15 SR), FVC 4.50L (2.52 SR), FEV_1/FVC ratio of 0.90 and a peak expiratory flow of 463L/min (0.12 SR). Results of Mannitol challenge testing were consistent with mild bronchial hyperresponsiveness (15% fall in FEV_1 occurring at 635mg) and nebulised salbutamol (2.5mg) returned the FEV_1 to +4% of baseline values. Total immunoglobulin E (IgE) was normal as were specific immunoglobulins for house dust mite, cat and dog dander, grass pollen, tree pollen and aspergillosis fumigatus. 24 hour pH monitoring did not show any evidence of significant reflux. Due to the lack of objective evidence of significant respiratory disease full cardiopulmonary exercise testing was performed. The patient performed 9 minutes of a 15 watt incremental cycle test. Peak VO_2 was mildly reduced at 1689ml/min (76% predicted) and anaerobic threshold occurred at 17.6 ml/kg/min VO_2 (54% predicted VO_2). Respiratory exchange ratio at peak exercise was 0.95 and the heart rate reserve was slightly elevated suggesting a sub maximal test.

There was no evidence of ventilatory limitation however the patient did demonstrate hyperventilation at rest and during unloaded exercise. In all the results did not suggest impairment sufficient to cause her symptoms. Inspection of her resting 12-lead ECG revealed a short PR interval and delta wave consistent with Wolff-Parkinson-White Syndrome. Following cardiology review she underwent successful radio- frequency ablation of her septal accessory pathway.

TP7 A COMPARISON OF SPIROMETRY AND TRANSFER FACTOR DATA OBTAINED FROM MOBILE AND LABORATORY EQUIPMENT.

Farrow, J and Unstead, M. Department of Respiratory Medicine, Royal Berkshire Hospital NHS Foundation Trust.

Introduction: Research has investigated the accuracy and intra-subject variability of T_LCO on the EasyOne Pro, ndd1 however, there is a lack of research on the comparison of Spirometry and T_LCO between EasyOne and Carefusion Jaeger MS-PFT.

Methods: Patients (n=72) with both obstructive and restrictive lung conditions (FEV_1:0.71-4.41L, FVC:1.25-6.17L, T_LCO:1.28-12.48mmol/min/kPa, KCO:0.51-2.02mmol/min/kPa/L) performed Spirometry and T_LCO measurement on EasyOne and MS-PFT. The patients also performed lung volumes via helium dilution on MS-PFT. SD, and Mean difference were calculated. Bland-Altman plots were used to analyse the comparison between EasyOne and MS-PFT.

Results:

	FEV1	FVC	PEF	MEF_{75}	MEF_{50}	MEF_{25}	TLCO	KCO	VA	VA and TLC
M	-0.03	-0.08	0.23	0.12	0.15	0.07	-0.22	-0.09	0.14	-0.39
SD	0.16	0.17	0.85	0.98	0.61	0.24	0.50	0.10	0.34	0.65

Table 1. Mean Difference, Standard Deviation Difference, of EasyOne compared with MS-PFT.

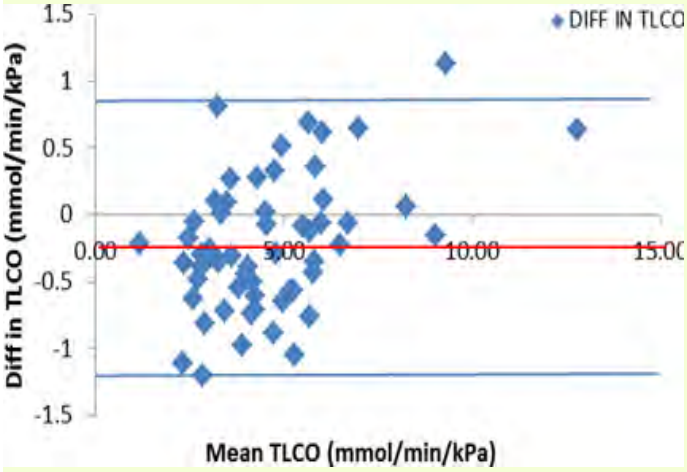

Figure 1. Bland-Altman: T_LCO EasyOne Vs MS-PFT

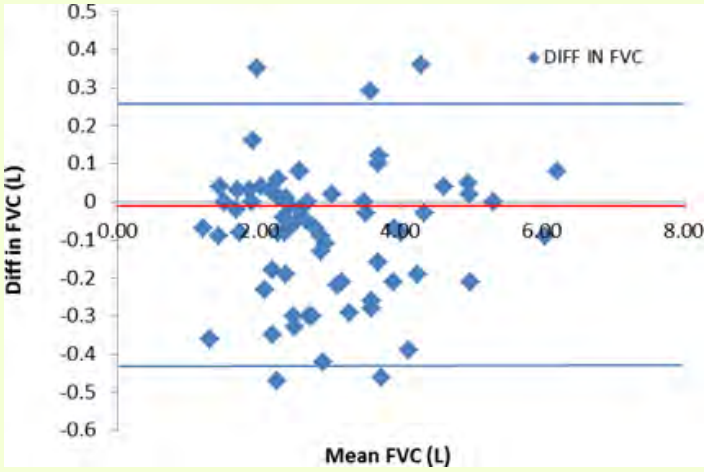

Figure 2. Bland-Altman: FVC EasyOne Vs MS-PFT

Conclusion: Clinically consistent Spirometry and T_LCO results were obtained from the EasyOne and MS-PFT. Small differences in PEF and T_LCO between equipment are most likely caused by principles of measurement. Therefore when portability is required for service provision, mobile transfer factor equipment is an accurate and cost effective alternative to laboratory systems.

References:

1. Jenson, R. et al. European Respiratory Journal 2015; 46(59).

This audit was supported by the RBHFT Respiratory Medicine charitable fund.

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TP8 A TRIAL OF THE CLINICAL IMPLEMENTATION OF HAEMOGLOBIN MEASUREMENT FOR GAS TRANSFER

J. Gadher, J.A. Stockley, B.G. Cooper. Lung Function & Sleep, Queen Elizabeth Hospital Birmingham, B15 2GW

Rationale: The 2017 ERS/ATS standards for single-breath carbon monoxide uptake in the lung (Graham et al. Eur Respir J 2017; 49(1). pii: 1600016) state that carbon monoxide–haemoglobin (COHb) binding is an important factor in carbon monoxide transfer and T_LCO changes can be substantial as a function of Hb concentration. We sought to determine whether or not performing point of care Hb analysis and correcting gas transfer results would affect the clinical interpretation of the results and impact on our clinical service.

Methods: 203 patients were recruited to the study. Hb was analysed using a HemoCue system (Radiometer Ltd., UK) during the same visit for routine single breath gas transfer for carbon monoxide (Medical Graphics, UK). Uncorrected T_LCO (T_LCOUNC) and T_LCO corrected for Hb (T_LCOCOR) were compared by Spearman's Rank Correlation, Wilcoxon Signed-Rank Test and Bland-Altman Plot.

Results: There was a very strong, significant correlation between T_LCOUNC and T_LCOCOR ($r2 = 0.983$, $p < 0.0001$) and no significant difference between the two groups of data. The group mean difference between T_LCOUNC and T_LCOCOR was -0.11 mmol/min/kPa (SD 0.32). The data was not widespread and the majority (90%) fell within 1 S.I. unit (+/-0.5 mmol/min/kPa). Hb correction in two patients with large differences between T_LCOUNC and T_LCOCOR brought abnormal T_LCO results back into the normal range.

The HemoCue kit is relatively inexpensive (£580 initial cost, 70p per Hb sample) and was reported as quick and easy to use by all physiology staff.

Conclusions: Although T_LCOUNC and T_LCOCOR agreed on average, in terms of personalised medicine, 10% had clinically significant differences. This impacted on interpretation and could potentially influence serial monitoring of gas transfer data. Consequently, performing point of care Hb measurements for correcting T_LCO should be considered in routine clinical practice.

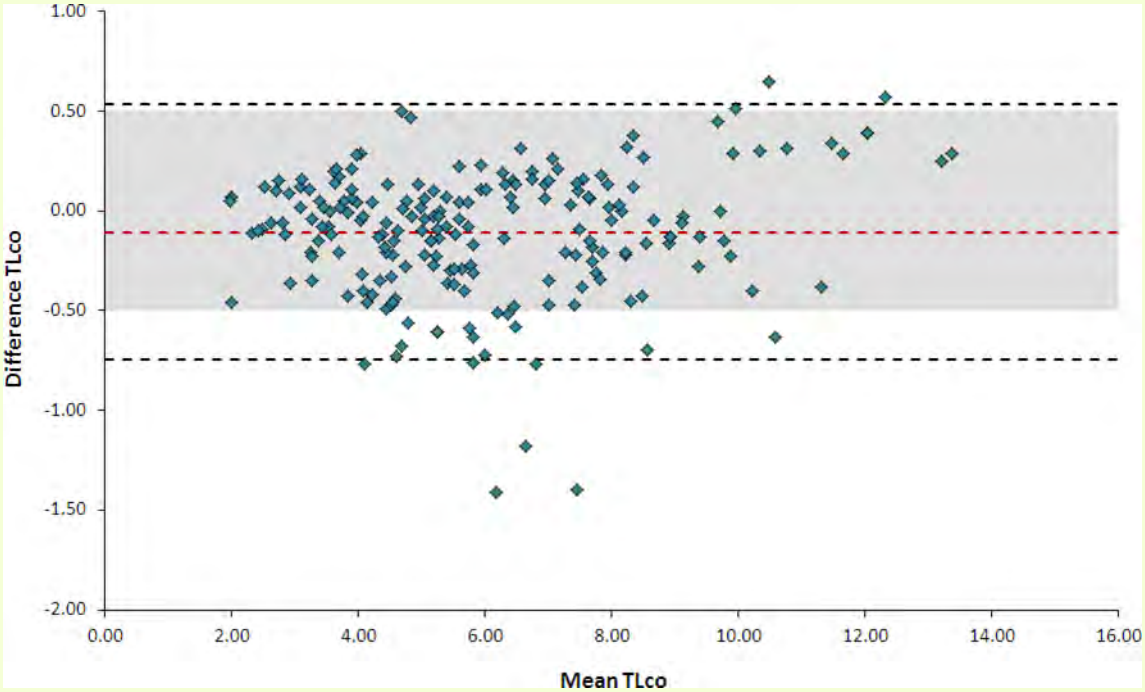

Figure 1: A Bland-Altman plot comparing T_LCOUNC and T_LCOCOR in 203 patients. Mean difference is shown by the red dotted line and +/- 2SD by the black dotted lines. The grey area indicates the clinically acceptable difference of 1 S.I. unit.

TP9 CROSS-SITE EXTERNAL BIOLOGICAL CONTROL (BIOQC) IN CARDIOPULMONARY EXERCISE TESTING EQUIPMENT.

Dos Santos, C: Respiratory Sleep Unit, Great Ormond Street Hospital, London, England.

Background: Cardiopulmonary Exercise Testing (CPET) is used to monitor progression in chronic disease. BioQC is an important laboratory routine, to ensure adequate equipment function and reassurance about test reproducibility. Standards are often set locally, rather than by international guidelines. This study looked at the reproducibility of CPET across multiple hospitals. Keteyian el al 2010, suggested an optimal coefficient of variation (CoV) for maximal oxygen uptake ($\dot{V}O_2$max) of <5.9%. This would be useful clinically in patient groups requiring frequent CPETs, to monitor disease progression.

Methods: Multiple CPETs were performed across London hospitals on the same 20 year old male test subject using cycle ergometer with differing test operator and equipment per department. Protocol used 12 minute ramp 30 W/min; target load of 360W. Primary outcomes measured were: peak oxygen uptake ($\dot{V}O_2$peak); carbon dioxide output ($\dot{V}CO_2$); minute ventilation ($\dot{V}_E$); respiratory exchange ratio (RER); and oxygen uptake at anaerobic threshold ($\dot{V}O_2$'AT). Variability and CoV were compared.

Results: 6 exercise tests were performed, showing CoV for $\dot{V}O_2$peak of 5.24% (mean 3958ml/min). $\dot{V}_E$ (6.57% - mean 132L/min); $\dot{V}CO_2$ (8.59% - mean 5021ml/min); RER (8.61% - mean 1.27); and higher for $\dot{V}O_2$'AT (26.68% - mean 2276ml/min) (Figure 1).

Conclusion: $\dot{V}O_2$peak was within 5.9%, which is reassuring as $\dot{V}O_2$peak is often used to determine level of fitness. All other measures, with the exception of $\dot{V}O_2$'AT, were <10%. When considering the sample size and the fact the test individual was not blinded to the outcome of the research, this data is encouraging and heightens the importance of external BioQC. The large CoV for $\dot{V}O_2$'AT is concerning as many centres use $\dot{V}O_2$'AT for risk stratification in patients undergoing major surgery. This variation is likely related to the fact that this value is derived, making it subject-dependent.

Reference:

1. Keteyian, S. J. (2010) "Reproducibility of Peak Oxygen Uptake and Other Cardiopulmonary Exercise Parameters", Chest, 138(4), pp. 950-955

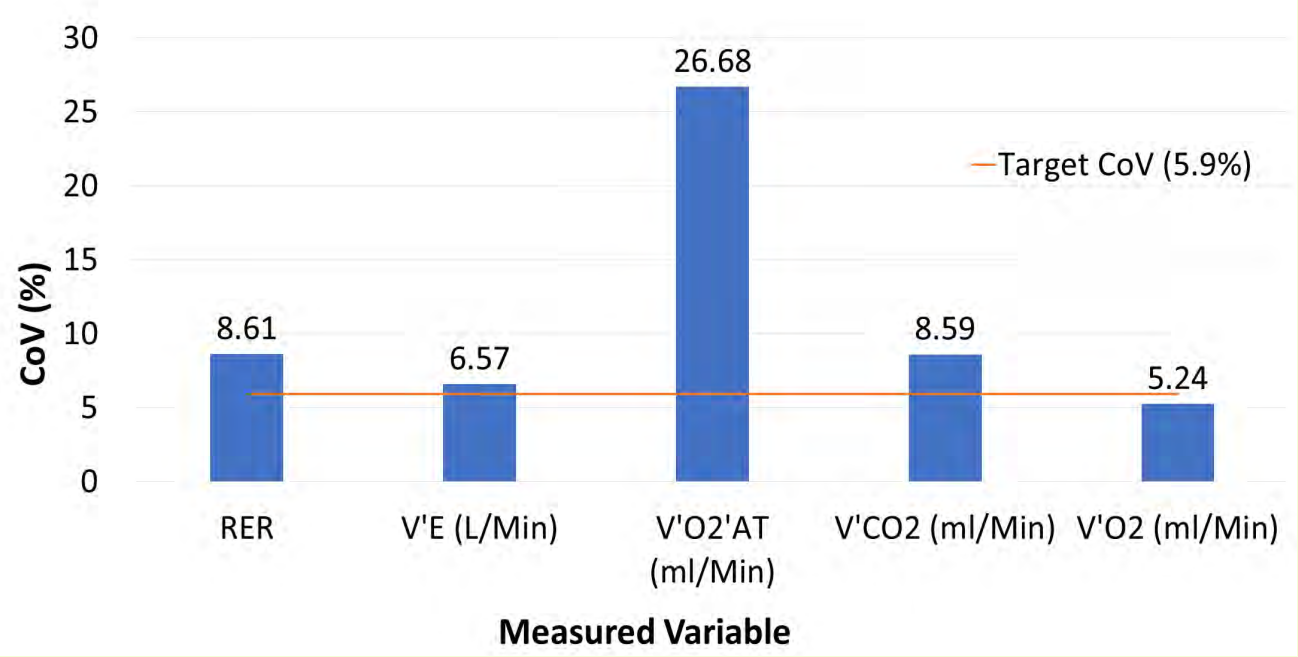

Figure 1: CoV (%) for CPETs performed at different centres for different measured CPET variables

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TP10 IS IMPULSE OSCILLOMETRY (IOS) USEFUL AT DETECTING BRONCHIOLITIS OBLITERANS SYNDROME (BOS) IN LUNG ALLOGRAFT RECIPIENTS?

Tasmin Sharley, Jodie Hunt, Brendan Cooper (Lung Investigation Unit, Queen Elizabeth Hospital Birmingham, Birmingham, U.K.)

Background: BOS is a form of chronic lung-allograft dysfunction associated with progressive small airway obstruction and increased mortality. Spirometry diagnoses and monitors BOS, however it may not represent small airways function. IOS detects small airway dysfunction by measuring respiratory resistance and reactance. This study intended to determine if pathophysiological BOS changes could be detected earlier using IOS than spirometry.

Methods: Spirometry and IOS was performed as routine follow-up post lung transplant. Data was collected retrospectively from 50 randomly selected lung-allograft recipients (mean age±S.D. 54.2±8.6 years). Data from 1418 spirometry and 847 IOS tests were analysed. The outcome measure was number of days to a significant change for spirometry and IOS (Fres, R5, R20, X5) parameters. A significant change was defined as 20% and 25% deterioration from baseline for FEV_1 and FEF_{25-75} respectively and 10,20,30,40 and 50% deteriorations from baseline were tested for IOS parameters. Friedman's test compared the number of days to significant change in IOS to spirometry, Wilcoxon's test compared changes in FEV_1 to FEF_{25-75}. Sensitivity and specificity analyses were performed on each parameter.

Results: Sensitivity and specificity for BOS was lower for IOS compared to FEV_1 (Table 1) however a 10% decline in IOS detects lung function deterioration before 20% change in FEV_1 ($p=0.011$). There was no difference between 10% decline in all studied IOS parameters and 20% X5 decline to FEF_{25-75}($p>0.05$).

Parameter	FEV_1	FEF_{25-75}	F_{res}	R_5	R_{20}	X_5
Sensitivity	86%	91%	50%	55%	68%	73%
Specificity	57%	29%	46%	46%	57%	39%

Table 1. Sensitivity and specificity for BOS for each parameter (10% decline from baseline for IOS parameters).

TP11 THE V_A ADJUSTED RV/TLC RATIO: A NOVEL APPROACH TO DEFINING GAS TRAPPING IN SEVERE COPD.

Knox-Brown B[1], Rathbone, A[1]; Mahadeva R[2], Sylvester, K [P1,2]

1. *Lung Function Department, Cambridge University Hospitals, Cambridge.*
2. *Cambridge COPD Centre, Cambridge University Hospitals, Cambridge*

Introduction: The ratio between Alveolar Volume and Total Lung Capacity (V_A/TLC) has been suggested previously as a method of describing ventilation inhomogeneity and gas trapping in obstructive lung disease, a consensus regarding the lower limit of normal (LLN) for V_A/TLC remains elusive.

Methods: We examined whether adjusting the Residual Volume (RV) and RV/TLC ratio using the volume of gas trapping calculated from the V_A/TLC can be used to better describe gas trapping in patients with severe COPD. Data from 55 Patients (39 male, 16 female; mean age 65.86yrs SD 8.59yrs) referred to the Cambridge COPD Centre at Cambridge University Hospital was analysed. All patients performed a full lung function test as part of standard care. V_A was obtained via single breath gas transfer measurement and TLC via body plethysmography. Volume of gas trapping in litres (L) was estimated at three different LLN for V_A/TLC; 0.80, 0.825 and 0.85(1, 2, 3) using the calculation (TLC(L) *LLN)-V_A(L). Estimated volume of gas trapping (L) was then subtracted from measured RV and used to calculate the V_A adjusted RV/TLC ratio ((V_A)RV/TLC). Data was analysed using SPSS with mean and standard deviation (SD) describing population averages. One sample t-test was used to determine if (V_A)RV/TLC at each LLN was significantly different from the population predicted mean. Pearson correlations were used to describe relationship between gas trapping and other lung function measurements.

Results: Mean (SD) V_A/TLC ratio for this population was 62.58% (10.33%), demonstrating significant gas trapping (Table 1). Mean (V_A)RV/TLC for a LLN of 0.85 was significantly higher than the predicted population mean for RV/TLC ($t(54) = -2.947$, $P = 0.005$). There was no significant difference between (V_A)RV/TLC at 0.80 ($t(54) = 1.919$, $P = 0.06$) or 0.825 ($t(54) = -0.514$, $P = 0.609$) and the predicted mean, however calculation of gas trapping using the LLN 0.825 adjusted the RV/TLC most closely in line with the predicted mean (table 2). Volume of gas trapping was positively correlated with RV(L) $r = 0.79$, $P<0.001$, RV/TLC $r = 0.59$, $P < 0.001$ and FRC(L) $r = 0.70$, $P <0.001$.

Conclusion: In severe COPD the V_A/TLC ratio with a LLN of 0.825 can be used to estimate volume of gas trapping more accurately than a LLN of 0.80 or 0.85. The principle of the (V_A)RV/TLC ratio demonstrates that the RV and RV/TLC are effective measures of gas trapping in COPD.

References:

1. Burns CB et al (1994). Evaluation of single-breath helium dilution total lung capacity in obstructive lung disease. Am Rev Resp 130: 580-583.
2. Roberts CM, et al (1990). Multi-breath and single breath helium dilution lung volumes as a test of airway obstruction. ERJ, 3(5), 515-520.
3. Cotes JE (1971). Lung volume indices of airway obstruction. A suggestion for a new combined index. Proc R Soc Med 64: 1232-1234.

VA/TLC LLN	N	Gas Trapping (L)
0.80	55	1.46 (.86)
0.825	55	1.66 (.88)
0.85	55	1.86 (.91)

Table 1. Mean gas trapping in Litres with (SD) at each LLN for V_A/TLC

RV/TLC Predicted Population Mean	N	RV/TLC Measured	$_{(VA)}$RV/TLC 0.80	$_{(VA)}$RV/TLC 0.825	$_{(VA)}$RV/TLC 0.85
40.15 (2.9)	55	60.09 (8.00)	42.12 (7.62)	39.62 (7.62)	37.12 (7.62)*

Table 2. Demonstrates (V_A)RV/TLC compared to the predicted population mean for RV/TLC. *<0.05.

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TP12 A 38 YEAR OLD FEMALE WITH PERSISTENT SHORTNESS OF BREATH AND WHEEZE

Shakespeare, J; Parr D. Department of Respiratory Physiology and Sleep United Kingdom

Introduction: A 38 year old African female with a history of asthma and HIV presented with a history of shortness of breath, wheeze and productive cough. Her medical history included pulmonary tuberculosis, which she reported had been treated 16 years previously with 'traditional medicine' in the Congo. There was no history of smoking. BMI was 28.35 kgm^2, blood pressure 124/68 mmHg, oxygen saturation on air 99% with a regular pulse of 90 bpm. On pulmonary auscultation there was widespread inspiratory and expiratory wheeze, stridor with recurrent cough on forced respiratory movements. She was referred for full lung function tests with a provisional diagnosis of asthma and bronchiectasis. Lung function testing demonstrated a PEFR of 295 L/min (-1.60SR), FEV_1 1.43L (-3.18), FVC 1.78L (-2.98) and an FEV_1/FVC of 0.80. Total lung capacity and functional residual capacity via helium dilution were measured at -1.12 and -2.16 SR's, respectively. Transfer factor (T_LCO) was 0.75 SR with a significantly elevated KCO at 4.35 SR's. Results were not in keeping with the provisional diagnosis and reasons for referral. Due to the suggestion of an extra thoracic restriction body plethysmographic lung volumes were undertaken. FRC_{pleth} and TLC_{pleth} were within normal limits at -0.42 and -0.95 SR's respectively. These results suggested that the patient had a non-ventilated area of her lungs and was subsequently referred for CT scanning. CT results demonstrated normal looking lungs however there was a stenosis of left main stem bronchus. Further investigations included bronchoscopy and ventilation perfusion imaging which revealed almost complete absence of ventilation and perfusion of left lung due to bronchostenosis of the left main stem bronchus following endobronchial tuberculosis, consistent with a functional pneumonectomy. This study emphasises the role of lung function testing in a patients pathway and the importance of modifying investigations to further aid diagnosis and treatment.

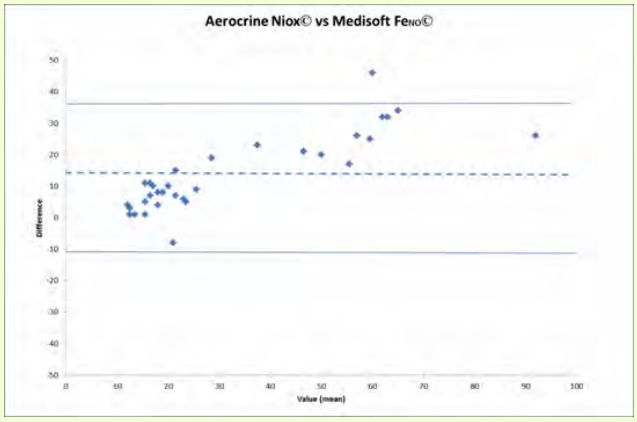
TP13 A COMPARISON OF TWO COMMERCIALLY AVAILABLE F_eNO MEASURING DEVICES

Elkington, H; Hurst, C; Cliff, I; Royal Stoke University Hospital, UK

Introduction: Nitric oxide is produced in the lungs, can be measured in exhaled breath and has been proposed as a non-invasive marker of airway inflammation, recommended for use in the management of asthma[1]. Fractional exhaled nitric oxide (F_eNO) levels have been found to be raised in patients with eosinophilic asthma, a distinct phenotype that may respond to treatment with corticosteroids. The aim is to evaluate two commercially available devices measuring F_eNO to compare measurements for interchangeable management of patients within a clinical setting.

Materials and Methods: Thirty-four random F_eNO measurements were taken from individuals over a three week period on both the Medisoft F_eNO (laboratory based device currently used in practice) and Aerocrine Niox (newly purchased portable device) equipment. The results were documented and the agreements assessed using the method described by Bland and Altman with paired T test to measure the difference in mean and 2-Sample test for the standard deviation.

Results: The findings showed that the F_eNO values measured by the Aerocrine device were higher than that of the Medisoft. There was also a significant difference between the mean ($p < 0.001$) and variance ($p = 0.031$) with the Aerocrine displaying the broader range. This difference increases further at larger values. These devices could not be used interchangeably within the same service or patient group. The limitation of this study



is that the author does not have a standard value to reference, and is unable to deduce whether there is under- or over-reporting of values.

Conclusion: Currently the Medisoft and Aerocrine Niox systems cannot be used interchangeably within a clinical service. Further work is required to ascertain which device measures the true value.

Reference: 1. SIGN. Thorax 2014; 69(Suppl 1), i1-i192.

PD1 A STUDY COMPARING SUBJECTIVE AND OBJECTIVE MEASURES OF NASAL RESPONSE TO ALLERGEN IN ADULTS WITH CHALLENGE-PROVEN OCCUPATIONAL ASTHMA

S. Sivagnanasithiyar Co-authors: J. Szram, P. Cullinan, R. Boyle, J. Cannon, B. Fitzgerald, J. Welch, Imperial University, England; Occupational and Environment Respiratory Department, Royal Brompton Hospital, London, England

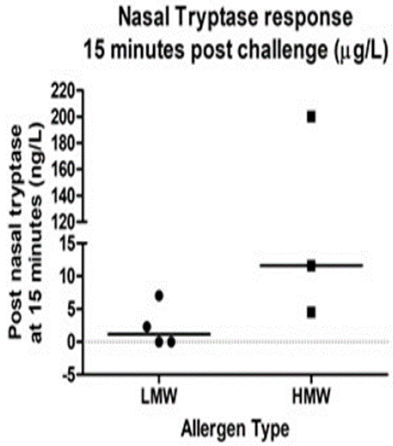
Introduction: Workplace respiratory allergens causing occupational asthma (OA) and occupational rhinitis (OR) are categorised into high molecular weight (HMW) agents and low molecular weight (LMW) agents[1]. OA has a well described diagnostic pathway where the gold standard test for diagnosis is a specific inhalation test. However, with OR, there is no such gold standard and therefore there is a need for objective tests for this disease allowing accurate diagnosis at an early stage.

Method: Ethical approval was obtained from the Leicester Central Research Ethics Committee. The prospective observational study recruited adult workers with suspected OA or OR, who had been exposed to either LMW or HMW agents. They all underwent SIC and then objective and subjective nasal measurements were compared: Nasal tryptase and Total Nasal Symptom Score (TNSS) respectively. The primary endpoints were early and late phase TNSS and the secondary outcome measure was early and late phase nasal tryptase measurements. Prospective patients exclusively performed peak nasal inspiratory flow (PNIF) throughout the challenge and RQLQ at baseline.

Results: HMW-OA n=3 and LMW-OA n=4. A greater proportion of atopy, cigarette smoking and lower mean age was seen in the HMW than LMW group. TNSS Early phase nasal response was higher in the HMW group but this was not statistically significant (p=0.40). Similarly, early phase nasal tryptase was higher in the HMW (median 11.6 µg/L range 4.5, 200) than LMW group (median 1.15 range 0, 7.0) but not statistically significant (p=0.11). Late phase nasal symptoms responses and early and late phase bronchial responses to allergen were similar between the two groups.

Conclusion: Nasal response in HMW-OA and LMW-OA cases may differ during SIC. Whilst this study lacked statistical power to confirm this difference, the findings are consistent with existing evidence that HMW-OA, in particular Baker's asthma, is associated with more rhinitis symptoms than LMW-OA. HMW-OR and LMW-OR may have different underlying mechanisms, implicating potentially alternatively pathological pathways.

Figure 1: shows nasal tryptase responses µg/L taken 15 minutes (both LMW and HMW) after specific inhalation challenges (4 vs. 3, p=0.11)



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PD2 CAN CARDIOPULMONARY EXERCISE TESTING PREDICT POSTOPERATIVE OUTCOMES AFTER ENDOVASCULAR AORTIC REPAIR?

E. Parkes. UCHW

Introduction: Endovascular aortic repair (EVAR) is a minimally invasive alternative surgical intervention to open abdominal aortic aneurysm (AAA) repair. EVAR involves the insertion of a stent graph through the femoral arteries and then the deployment within the enlarged section of the AAA. As a result EVAR places less metabolic stress on the patient in the post-operative period and therefore is the favoured surgical option in those patients who may not meet the preoperative fitness required for open surgery.

Cardiopulmonary exercise testing is an incremental maximal exercise test performed either on a cycle ergometer or a treadmill that allows assessment of a patient's global response to exercise. Breath-by-breath gas analysis combined with electrocardiography (ECG) allows objective measurements of a patient's ventilatory, ventilatory-perfusion, cardiovascular and metabolic changes during exercise to be obtained. These measurements include maximal oxygen uptake (peak VO_2), oxygen uptake at the anaerobic threshold (AT) and breathing equivalent for carbon dioxide ($Eq.CO_2$).

A VO_2 AT of 11ml.min.kg has been previously reported to correlate with post-operative outcomes including length of hospital stay (LOS) and the requirement for ITU care in those patients who underwent open or major abdominal surgery. There is, however limited information available regarding CPET's ability to predict outcomes in patients undergoing minimally invasive abdominal surgery.

The purpose of this study is to identify if a relationship exists between CPET and LOS and ITU care in patients who underwent EVAR.

Methods: All patients who attended the respiratory physiology department since July 2014 for preoperative CPET and then went on to have EVAR were reviewed. Demographics were obtained from the patients electronic records. CPET results, including peak VO_2, VO_2 AT and $Eq.CO_2$ were recorded from the exercise report. LOS and ITU care were recorded from the patients surgical records and outpatient clinic letters. LOS was calculated from the day after surgery to the date of discharge.

LOS and ITU care were compared between patients who achieved a VO_2 AT of < or > 11ml.min.kg.

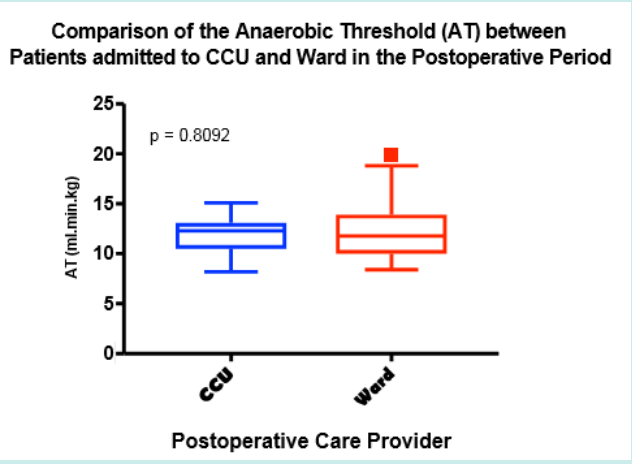
Statistical analysis was performed using GraphPad Prism 7 software. Correlations between data sets were made using Spearman's rank order correlation and the Mann Whitney U test.

Results: Patient demographics are reported in Table 1. There were no relationships between peak VO2 AT or Eq.CO2 and LOS (r=-0.0997; p=0.3957, r=0.1409; p=0.3947; r=0.05575; p=0.6347, respectively). There were no statistical differences in LOS when using a AT threshold of < or => 11ml.min.kg (3 vs 2 days, p=0.1775). There was no statistical difference in AT between those patients admitted to CCU or ward post surgery (12.3 vs 11.7ml.min.kg; p=0.08092, respectively).

Conclusion: This study concludes that the AT derived from the performance of preoperative CPET is unable to predict a patients LOS or if they are likely to require CCU post surgery. The widely used threshold of 11ml.min.kg may not be an appropriate marker of a patients preoperative fitness for an EVAR and if used may exclude patients who are fit for EVAR from having any surgical intervention.

n=77	Median (IQR)
Age (years)	75 (69-78)
BMI (kg/m2)	28.6 (25.75-31.65)
AAA Size (cm)	5.7 (5.5-6.15)
FEV_1 (%)	89 (72-103)
FVC (%)	96 (86-113)
VO_2 peak (ml.min.kg)	17.3 (15.1-21)
AT (ml.min.kg)	12.1 (10.2-13.7)
$Eq.CO_2$ (units)	36 (33-39)

Table 1.



PD3 LUNG FUNCTION DECLINE IN OCCUPATIONAL ASTHMA (OA): A COMPARISON OF IRRITANT-INDUCED ASTHMA AND SENSITISING OA.

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Introduction: Occupational asthma (OA) is caused by exposure to airborne irritants, allergens, or sensitising agents in the workplace and is divided into the subgroups of sensitising OA (sOA) or irritant-induced asthma (IIA). A recently identified subgroup of IIA imitates sensitizing OA and it is not currently known whether this group differs prognostically to the sOA group. To determine this, the rate of lung function (FEV_1) decline during and after workplace exposure was analysed in these 2 groups.

Material & Methods: Retrospective analysis of lung function in 373 workers diagnosed with OA due to known irritant agents (e.g. welding fumes, diesel exhaust, and plaster dust) compared to a group with OA due to the known sensitizing agents, isocyanates. Cases were identified from a local occupational lung disease surveillance database (surveillance of work-related and occupational respiratory disease; SWORD). Patients were excluded if significant comorbidity would impact lung function decline (e.g. COPD, asbestosis, bronchiectasis). A minimum of 18 months FEV_1 data was required to calculate decline using linear regression analysis. Kruskal-Wallis test was used to compare groups during and after exposure to causative agent. FEV_1 decline data is presented as median (IQR).

Results: There were 36 cases eligible for analysis (IIA = 12, sensitising OA =24). Mean (±SD) age was 46.6 (11.3) years for L-IIA and 45.3 (9.2) years for sOA. Both groups had a 100% rate of inhaled corticosteroid use, and both demonstrated similar rates of atopy and non-specific bronchial hyperresponsiveness via methacholine challenge. FEV_1 decline was not different during exposure (IIA = -25.63 (577.40) ml/year, sOA = 3.18 (304.49) ml/year) or after exposure (IIA = -0.08 (54.98) ml/year, sOA = 48.02 (88.83) ml/year) [p = 0.53].

Conclusions: There was no observed difference in lung function decline between patients with IIA and sOA that during or after exposure in the workplace. Previous work has shown these populations to have similar clinical characteristics, and the present study demonstrates further similarities between the groups. This may indicate no need to distinguish between them in the literature.

PD4 LUNG FUNCTION IN ALSTROM SYNDROME

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Introduction: The University Hospital Birmingham takes national referrals for Alstrom patients; a rare condition that has multi-organ dysfunction including diabetes, obesity and sudden respiratory failure later in life.

Materials & Methods: We measured spirometry, lung volumes and gas transfer using the MasterScreen (Jaeger Ltd, Hochburg, Germany) in 31 patients [Sex 21M:10F, Mean (SD); Age (Yrs) 28.0 (10.8), Weight (kg) 81.0 (24.1), Height (m) 1.59 (0.09); BMI 31.5 (7.1)].

Results: Compliance with testing varied from 39% (T_LCO) to 87% (Spirometry). Table 1 shows the spirometry parameters in absolute values, with the FEV_1/FVC indicating a generally restrictive pattern. Lung volume and gas transfer data are expressed as SRs and show overall restrictive lung volumes and reduced gas transfer (T_LCO) with a relatively preserved KCO consistent with extrapulmonary restriction.

Table 1: Lung Function Data

Mean (SD)	Mean (SD)	n =
FEV_1 (L)	2.37 (0.9)	18
FVC (L)	2.58 (1.1)	22
FEV_1/FVC	0.87 (0.7)	18
TLC (SR)	-2.05 (1.1)*	16
FRC (SR)	-1.95 (0.7)*	16
RV (SR)	-0.93 (0.9)	16
T_LCO (SR)	-1.74 (1.4)*	12
KCO (SR)	0.30 (1.4)	12

*Abnormal result (< -1.645

Conclusion: Lung function in Alstrom Syndrome has rarely been studied. We suspected some underlying respiratory disorder which may contribute to their respiratory failure later in life. We show that overall there's a pattern of extrapulmonary restriction which is seen in obesity and diabetes (Cooper et al, Respir Med 1990; 84: 235-9). Patients with Alstrom Syndrome can show extrapulmonary restriction secondary to obesity.

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PD5 SERIAL MEASUREMENTS OF FORCED EXPIRATORY VOLUME IN ONE SECOND (FEV_1): AN IMPROVED DIAGNOSTIC TOOL FOR OCCUPATIONAL ASTHMA?

E. Parkes. UCHW

Introduction: The use of serial PEF measurements in the diagnosis of occupational asthma (OA) using the OASYS program has been well defined, giving a sensitivity and specificity of 72% and 100% respectively for ABC clock time. This study aims to identify if FEV_1 measurements improve the sensitivity and specificity.

Methods: Patients investigated for OA between 2004 and 2016 were retrospectively reviewed. The ABC score was calculated from FEV_1 diaries containing >4 day shifts, >4 rest days and ≥6 readings per day.

Patients were grouped into: OA positive and OA negative. Receiver operator characteristic (ROC) curve analysis was used to determine the threshold from the ABC score by clock time and time from waking that identified the best specificity and sensitivity for a diagnosis of OA.

Results: Fifty four patients were included (26 OA positive; 28 OA negative). Median PEF diurnal variation was 18.3% (IQR 12.4-27.5) for OA positive and 17.1% (IQR 12-28.5) for OA negative (p=0.795). ROC analysis showed an area under the curve for ABC clock time and time from waking of 0.751 and 0.699, respectively. A threshold of 0.006L/hr provided a sensitivity of 73% and a specificity of 75% (Table 1).

	ABC Clock Time		ABC From Waking	
Threshold L/hr	Sensitivity	Specificity	Sensitivity	Specificity
0.072	50	93	46	86
0.035	69	86	54	82
0.006	73	75	58	64

Table 1 - Cut-off Values for Sensitivity and Specificity for both ABC Score for Clock Time and ABC Score From Waking

Conclusions - The ABC FEV_1 score is less sensitive and specific in the diagnosis of OA compared to the ABC PEF score, probably due to the greater reproducibility of self-recorded PEF measurement. The continued use of serial PEF measurements in the diagnosis of OA is recommended.

PD6 SHOULD WE USE FINGER OR FOREHEAD SENSORS TO MEASURE OXYGEN SATURATION DURING THE SIX MINUTE WALK TEST?

L C Robertson, R Lowry, M Thillai, K P Sylvester and K Oates 2017 Cambridge Respiratory Physiology, Papworth Hospital, Cambridge

Background: Finger sensor is commonly used to measure oxygen saturation (S_pO_2) during the six minute walk test (6MWT). The sensor is prone to error in measurement especially in patients with poor perfusion. This study determined if any difference in S_pO_2 and heart rate (HR) readings between forehead and finger sensors during 6MWT and also to examine if any differences were related to poor perfusion. Finally, the signal quality of the two sensors during the 6MWT was compared.

Methods: Ethical approval was obtained for the study. 80 patients with either pulmonary vascular or interstitial lung disease performed the 6MWT wearing 2 Masimo Rad-5 devices allowing both sensors to be worn. Measurements of S_pO_2 and HR were taken simultaneously from the device at 30 second intervals. Occurrence of poor signal quality for the measurements were recorded. Patient's hands were examined to determine whether they had poor perfusion.

Results: During 6MW, S_pO_2 was significantly higher ($p < 0.001$) in the forehead sensor (91.2 ± 6.7%; mean ±SD) compared with finger sensor (88.4 ± 8.69%). HR was higher in the forehead sensor (108.4 ± 23.3 bpm) compared with finger sensor (104.3 ± 24) during the 6MWT ($p<0.05$). Mixed repeated measure analysis of variance (ANOVA) was performed to investigate for significant interactions between forehead and finger sensor measurements for S_pO_2 and HR during the 6MWT. Wilcoxon signed rank test showed higher occurrence ($z< 0.001$) of poor signal quality

	S_pO_2	HR
Factors	Significance	Significance
Sensor	P<0.001	P<0.05
Time	P<0.001	P<0.001
Sensor/Time	NS (p=0.05)	P<0.05
Poor perfusion/Sensor	NS	NS

Table 1: Summary of ANOVA results

measurements in finger sensor (199/1040) compared to forehead sensor (37/1040).

Conclusion: Forehead sensor was more reliable for signal quality during 6MWT. Forehead sensor recorded higher values for S_pO_2 and HR compared with finger sensor. Surprisingly, results indicate poor perfusion was not a contributing factor in the difference in sensor readings. This may reflect limitations in classifying perfusion and warrants further study.

PD7 SPECIFIC INHALATION CHALLENGE TESTING IN CONSECUTIVE PATIENTS WITH A WIDE RANGE OF OCCUPATIONAL AGENTS

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Introduction: Specific inhalation challenge testing (SIC) is the reference standard for the diagnosis of occupational asthma (OA), and is particularly indicated when there are a range of possible causes in an individual worker, or when the agents are novel.

Methods and aims: We have reviewed all positive tests between 2006 and 2015 to assess: 1. The role of non- specific bronchial reactivity (NSBR) in selecting those for testing, 2. The role of F_ENO 3. The calculation of the lower limit of normal for FEV_1 in evaluating late asthmatic reactions 4. The range of agents tested, the number of tests required and the specific causes found. Only one agent was tested per day after satisfactory control exposures.

Results: 343 workers were identified with OA in 2006-2015; 52 workers underwent SIC testing to find the cause; only 21% were to well recognised agents (isocyanates). Pre-test NSBR was normal in 54%, of whom 19/52 were currently exposed. F_ENO increased >10ppb post SIC in 3/31. A mean of 2.3 different agents were tested on each worker (range 1-6) over 3.5 separate challenges (range 2-8). The specific cause was identified in 9 exposed to mixed aerosols. Calculating the FEV_1 lower limit of normal (LLN) from 3 days of hourly measurements showed a mean required fall of 390 ml (SD 106), allowing the identification of significant late reactions in 9/18.

Conclusions: Occupational SICs enable the identification of specific causes of OA allowing control/avoidance to be advised. Only 46% with a positive SIC showed NSBR and only 10% had a clinically significant increase in F_ENO. Calculating the LLN helped identify late reactions.

PD8 STRUCTURED LIGHT PLETHYSMOGRAPHY AS A METHOD EVALUATING DISEASE SEVERITY COMPARED TO X-RAY AND LUNG FUNCTION IN CYSTIC FIBROSIS

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OBJECTIVE: Medical imaging cumulatively exposes individuals with Cystic Fibrosis (CF) to ionising radiation; the dosage increases with both age and severity of disease1. This study evaluates the potential of using breathing patterns measured by Structured Light Plethysmography (SLP), in support or surrogate to radiology.

METHOD: Clinically stable individuals diagnosed with CF were recruited to perform contemporaneously SLP, X-Ray and lung function (LFT) investigations (n=57, 38 male vs. 19 female, median (IQR) age 19 years (9), and BMI 19.7 (3.9)), X-rays were evaluated according to the established modified Chrispin Norman scoring system, assessed independently, with both scorers blinded to SLP results. NHS ethics approval and voluntary consent were required.

RESULTS: No X-Ray or LFT abnormality was detected below the age of 9 years. SLP outcomes were not significantly influenced by either gender or perception of breathlessness ($P<0.01$). The predominant X-Ray pathology was bronchial wall thickening, which initiated and progressed largely in the upper pulmonary zones. Inspiratory Time (Ti), and Time to Peak Expiratory Flow/ Expiratory Time (TPTEF/TE), decreased with severity of both LFT and X-Ray (Table 1, $P<0.05$). There was a concurrent decrease in the spontaneity of ribcage contribution and thoracoabdominal phase ($P<0.05$). SLP was able to explain up to 72 % of the variation in X-Ray pathology by multiple linear regressions.

FEV_1SR	RR(brpm)	Ti(s)	BreathPhase-UL2UR(deg)	Tptef/Te
-3.53	18.37	1.33	2.00	0.25
-2.13	18.38	1.40	2.19	0.30
-0.37	16.40	1.53	2.58	0.32
0.70	16.71	1.58	2.74	0.33

Table 1 - Raw Median and IQR Values by population quartile (Stratified by FEV_1 SR, n=57)

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PD9 THE FORCED OSCILLOMETRY TECHNIQUE IS NOT A USEFUL MARKER OF EARLY DISEASE IN ALPHA-1 ANTITRYPSIN DEFICIENCY

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Introduction: The small airways are a major site of airflow obstruction in COPD. There is increasing interest in developing tests that may detect early small airways dysfunction (SAD) to identify patients most at risk of developing COPD. Over recent years, the forced oscillometry technique (FOT) has proven a valuable clinical tool for assessing airways function in a variety of settings and the evidence that FOT can accurately isolate small airways function is promising. We sought to determine if FOT could be a useful marker of SAD in patients with alpha-1 antitrypsin deficiency (AATD).

Methods: 53 never- or ex-smokers with PiZZ AATD were included; (22 males: 31 females, median age 52 (range 31-77), median FEV_1 % predicted 103.0 (IQR 95.0-114.0), median FEV_1/FVC% 77.1 (IQR 68.6-81.9). FOT (Resmon-Pro, MGC Diagnostics, UK) and spirometry (Jaeger Masterscreen, Carefusion, UK) were performed post-bronchodilator (5.0mg salbutamol + 0.5mg ipratropium). Scatter plots of spirometric parameters versus FOT parameters were assessed visually and, if appropriate, with a Spearman's Rank correlation. Patients were grouped in accordance with their spirometry as described previously (Stockley et al, ERJ 2017; 49: pii: 1602055); Group 1 "Normal" (n=24), Group 2 "SAD" (n=10) and Group 3 "Mild COPD" (n=19). The difference in FOT parameters between groups was assessed with a Kruskal-Wallis test.

Results: No spirometric parameter correlated with any FOT parameter. When the patients were split into Groups 1-3, there was a slight visual trend for increased X5in % predicted in Group 2 compared to Group 1 but this, together with all other FOT parameters, was not statistically significant.

Conclusions: FOT does not appear to be a useful marker of early SAD in this group of AATD patients although, with a more appropriately powered study, X5in may yet prove clinically useful.

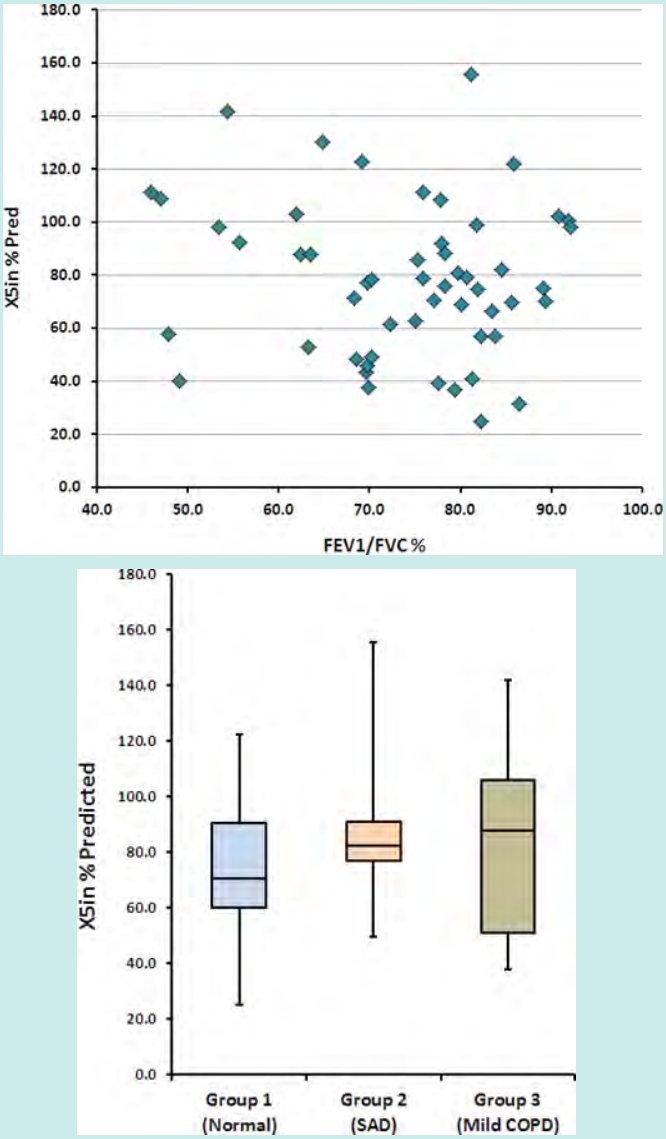

Figure 1: A scatter plot of FEV_1/FVC versus X5in % predicted showing no correlation (top) and a box and whisker plot showing median, interquartile range and minimum/ maximum X5in % predicted in Group 1 (normal), Group 2 (SAD) and Group 3 (mild COPD).

PD10 THE UTILISATION OF CARDIOPULMONARY EXERCISE TESTING (CPET) PRIOR TO OESOPHAGO-GASTRIC CANCER SURGERY TO PREDICT POST-OPERATIVE OUTCOMES

J Waterfall

Cambridge University Hospitals NHS Foundation Trust

Introduction: Currently, at Cambridge University Hospitals NHS Foundation Trust, patients' post-operative risk after oesophago-gastric cancer surgery is categorised using CPET as either low, intermediate or high based on anaerobic threshold (AT), maximal oxygen uptake (VO_2max) and oxygen pulse measurements[1]. The aim of this study was to determine whether patients classified as high risk had poorer post-operative outcomes compared to lower risk groups.

Methods: Data was reviewed retrospectively for 110 patients (median age: 68 yrs; range 32-82) who performed CPET between February 2014 and April 2016 prior to oesophago-gastric surgery. Post-operative risk was categorised into low, intermediate and high groups based on AT, VO_2max and oxygen pulse as described by Cooper and Storer[1]. Post-operative outcomes used to measure patient risk were cardio-pulmonary complications (Clavien-Dindo score), length of hospital stay (LOHS) and mortality (30 days post-surgery). Data were analysed using either one-way ANOVA or Chi-square test and are presented as median (interquartile range).

Results: In the high risk group the median AT, VO_2max and oxygen pulse were 9 $mL.kg^{-1}.min^{-1}$ (9-10), 13 $mL.kg^{-1}.min^{-1}$ (11-14) and 8 mL (7-9), respectively. In comparison to the low risk group who had a median AT, VO_2max and oxygen pulse of 17 $mL.kg^{-1}.min^{-1}$ (16-18), 24 $mL.kg^{-1}.min^{-1}$ (22-26) and 13 mL (11-14) respectively. There was no significant difference between LOHS and cardio-pulmonary complications between low, intermediate and high patient risk groups ($p>0.05$).

Table 1. Describes the number of cardio-pulmonary complications for CPET variables between post-operative risk groups. n=cases, * $p<0.05$.

Risk Category	Cardiopulmonary complications		
	VO_{2max} ($mL.kg^{-1}.min^{-1}$)	AT ($mL.kg^{-1}.min^{-1}$)	Oxygen Pulse (mL)
High	**50% (n=8)**	**35% (n=17)**	**49% (n=37)**
Intermediate	**40% (n=45)**	**45% (n=76)**	
Low	**49% (n=57)**	**59% (n=17)**	**44% (N=73)**

Conclusions: There is no association between greater patient risk, as categorised using CPET variables, and poorer outcomes post- oesophageal surgery. Further research is warranted to determine whether other CPET variables and/or a composite of such, may better predict surgical outcomes in this cohort of patients.

References:

1. Cooper CB, Storer TW. Exercise testing and interpretation: a practical approach: Cambridge University Press; 2001.

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PD11 WHICH BETTER PREDICTS CAPILLARY OXYGEN SATURATION DURING THE SIX MINUTE WALK TEST, A FOREHEAD OR FINGER OXIMETRY SENSOR?

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Background: Pulse oximetry is commonly used during the 6 minute walk test (6MWT). This study compared forehead and finger sensor readings to capillary blood gas(CBG) taken from the ear pre and post 6MWT.

Methods: Ethical approval was obtained for this study. 80 patients with either pulmonary vascular or interstitial lung disease performed 6MWT with 2 Masimo Rad-5 devices, allowing both sensors to be worn. CBG was collected pre and post 6MWT as a reference measure (S_cO2). To examine agreement between the sensors to the CBG, the median, bias and precision were calculated. Differences in bias and precision between sensors were evaluated by paired t-test.

Results: CBG was acquired in 65 patients at rest and 60 patients post 6MWT. Post 6MWT patients were grouped into those who desaturated (>3% decline from baseline S_pO_2 in either sensor) and those who had either fully recovered at time of CBG or had not desaturated during the 6MWT (<3% change from baseline S_pO_2). In patients who desaturated post 6MWT there was a significant difference in the bias between forehead and finger sensors with a wide variance (SD) for both sensors. In the majority of these patients the forehead sensor was found to overestimate S_pO_2 compared with S_cO_2, whereas the finger sensor was found to underestimate S_pO_2 compared with S_cO_2 and in the other patients found to overestimate S_pO_2. In patients who either did not desaturate or who had fully recovered to baseline at time of post walk CBG; it was found that the forehead sensor overestimated S_cO_2 in all but 2 patients (not reaching statistical significance difference in bias) whereas the finger sensor aligned more closely to S_cO_2 in the most of the patients.

	Rest (n=65)			Post 6MWT (desaturated) (n= 32)			Post 6MWT (not desaturated) (n= 28)		
	Values (%)	Bias	Precision	Values (%)	Bias *	Precision	Values (%)	Bias	Precision
S_cO_2	95 (94-96)	n/a	n/a	89 (81-91.5)	n/a	n/a	96 (95-96)	n/a	n/a
Forehead	97 (96-99)	2.81 ± 0.83	2.11 ± 1.28	90 (86-94)	3.75 ± 3.78	2.81 ± 2.49	98 (95.8-99)	2.14 ± 1.98	1.77 ± 1.04
Finger	96 (93-97)	0.81 ± 2.31	1.33 ± 1.12	88 (83-93)	1.62 ± 6.07	2.60 ± 3.63	95.5 (92.8-98)	0.0 ± 2.62	1.44 ± 1.19

Conclusion: The results suggest pulse oximetry may not give an accurate S_pO_2 in patients who desaturate during 6MWT. This is highlighted by a wide bias variance. Forehead sensors may overestimate S_pO_2 compared with S_cO_2 but further research is needed to clarify these results.

PD12 CONTINUOUS LARYNGOSCOPY EXERCISE (CLE) TEST TO DIAGNOSE EXERCISE INDUCED LARYNGEAL OBSTRUCTION (EILO): A NEW INNOVATIVE CLINICAL SERVICE

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Background: The larynx is a delicate and highly innervated organ that is responsible for complex physiological functions including speech, airway protection and swallowing. The diameter of the laryngeal lumen is dependent upon several factors including cartilaginous structure, movement of the vocal cords and aryepiglottic folds. The larynx functions autonomously most of time, however during exercise it can become 'dysfunctional' resulting in upper airway obstruction at either epiglottic or supra epiglottic levels. Such obstruction, termed EILO, can lead to a variety of respiratory symptoms at varying severities including shortness of breath, wheeze and stridor, which can severely limit exercise tolerance.
The CLE test is the gold standard diagnostic test for EILO. It consists of placing and securing a laryngoscope in the nasopharynx and observing the patient's upper airway during a continuous, symptom limited exercise test. The severity of EILO is assessed by visual inspection either during testing or during a post-exercise video replay. An accurate diagnosis of EILO informs further treatment and management of the patient.

Service Provision: Our department has a large cardiopulmonary exercise (CPET) service and tests over 360 patients a year from a wide range of services including vascular surgery, cardiology, upper GI surgery and respiratory. The service has the ability to offer three different exercise modalities: cycle ergometry; arm ergometry and treadmill. Anecdotally, we have observed an increased number of respiratory referrals for the investigation of other healthy patients with unexplained dyspnoea. During testing some of these patients elicit typical symptoms of upper airway obstruction, including wheeze and stridor, potentially due to EILO or exercise induced vocal cord dysfunction (EI-VCD). These patients had previously performed resting lung function tests including spirometry with reversibility and non-specific bronchial hyper-responsiveness tests (mannitol) which were negative.

Service Development: Contact was made with our colleagues in the ear, nose and throat (ENT) department with an invitation to work collaboratively on the development of a CLE service. A consultant ENT surgeon with a specialist interest in upper airway abnormalities, who had recently joined the Trust, accepted the invitation. At an initial meeting we discussed the proposed new service and developed plans for a pilot test. We were required to identify a suitable patient and to consider the practical requirements of testing including staffing, facilities, equipment and patient safety as well as a time when the multidisciplinary team could work cohesively.

Initial Testing: The selected patient demographics are shown in Table 1. Unfortunately, the patient did not attend the appointment but a member of staff volunteered to have the procedure carried out. A laryngoscope was placed and held in the nasopharynx for the full duration of a symptom-limited incremental cycle ergometry test. Concurrent breath-by-breath respiratory gas analysis was successfully conducted. This pilot test allowed us to identify potential problems and consider possible solutions which could be implemented at the next test. These included:

- Positioning of the cycle ergometer to ensure safe insertion of the laryngoscope
- Whether or not to administer local anaesthetic spray into the nasopharynx prior to testing
- The most efficient and effective order in which to fit and place the different pieces of equipment on the patient
- Securing and steadying the laryngoscope during exercise – the instrument could be attached to a helmet or held in place by hand
- Optimal positioning of the laryngoscope operator in relation to the patient

Further considerations when applying for commissioning of the CLE service-

- Funding as a day case or by tariff
- Diagnostic reporting
- Outpatient department capacity

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PD13 THE COMPARISON OF FUNCTIONAL RESIDUAL CAPACITY MEASURED BY PLETHYSMOGRAPHY AND MULTIPLE BREATH WASHOUT IN SCHOOLCHILDREN WITH CYSTIC FIBROSIS

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Introduction: Functional residual capacity (FRC) is the volume of gas in the lungs at the end of tidal expiration. FRC measured by plethysmography represents all intrathoracic gas volume including non-communicating poorly ventilated areas. FRC measured by multiple breath washout measures only the communicable regions. Therefore, when performing plethysmography and MBW, it is common for there to be discrepancy between the two FRC values.

Aims: The main objective was to compare the FRC measurements obtained from plethysmography with those measured by MBW in schoolchildren with cystic fibrosis. The secondary objective was to determine whether there was a difference in the FRC relationship between children with normal and those with abnormal lung function. The aim was to evaluate the clinical usefulness of performing the two FRC measurement techniques in paediatric cystic fibrosis.

Materials and Methods: This was a retrospective observational study, conducted between October 2015 and March 2017. The population included 55 schoolchildren who performed multiple breath nitrogen washout, plethysmography and spirometry, on the same clinic visit (in that test order).

Results: A strong correlation of R2=0.839 was found and a Wilcoxon test showed no significant difference between FRC measured by plethysmography and FRC measured by MBW (p=0.062).

Bland Altman analysis showed no systematic bias between systems; the percentage mean difference was close to 0 (4.39%). However, the limits of agreement were wide (-24.23% to 33%). Bland Altman analysis showed no clear relationship when comparing patients with normal and abnormal spirometry and when patients were classified by the LCI (see figure).

Conclusions: This study found that patients with cystic fibrosis show on average no difference between FRC measured by plethysmography or by MBW. However, a high FRC relationship variability between CF subjects (with both normal and abnormal lung function) was found. Comparing FRC between plethysmography and MBW in children with cystic fibrosis is subject to methodological and physiological differences such as, peripheral trapped gas and tissue N_2 excretion.

Reference: Jensen, R. et al., 2013 'Multiple breath washout: alternative to mass spectrometry,' PloS ONE. 8 (2), e56868.

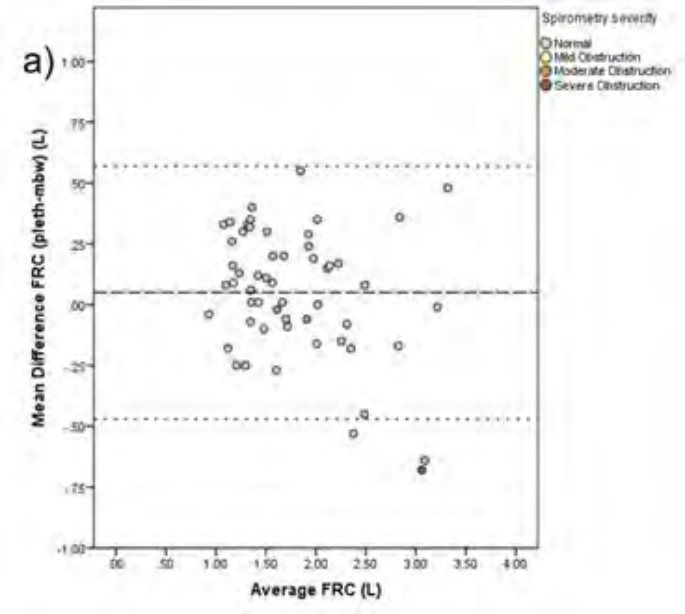

FIGURE 1: Bland Altman plot of the mean difference (FRC_{pleth}-FRC_{mbw})(L) vs average FRC(L) As shown on key, blue: normal spirometry. Yellow: mild airflow obstruction. Orange: moderate airflow obstruction. Red: severe airflow obstruction. The dashed line represents the mean difference/ bias line, and the dotted lines represent the LoA (mean difference±1.96SD) for the whole CF cohort.

PD14 ASSESSMENT OF VENTILATORY MECHANICS IN RESPIRATORY MUSCLE WEAKNESS USING STRUCTURED LIGHT PLETHYSMOGRAPHY

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Introduction: Structured Light Plethysmography (SLP) allows for non-contact, non-volitional assessment of ventilatory mechanics. SLP has already proven accurate and useful in detecting abnormal patterns of ventilation in a number of diseases, including dysfunctional breathing and COPD. Respiratory muscle diseases are commonly associated with impaired ventilation which, in the early stages of disease, may be undetectable by routine tests such as spirometry and respiratory muscle function. The usefulness of SLP as a diagnostic tool in respiratory muscle disease has yet to be investigated.

Materials & Methods: 25 patients with respiratory muscle disease were assessed in a seated and supine position using SLP (Pneumacare, UK). Outcomes included relative thoracic contribution (RTC), IE50 (ratio of inspiratory to expiratory flow at 50% tidal volume), Ti:Ttot (ratio of inspiratory time to tidal volume time) and Phase Angle, which assesses thoracoabdominal synchronicity (0° = fully synchronous, 180° = fully paradoxical). Results were compared to reference ranges from healthy individuals previously tested within our department.

Results: The signal during seated SLP was generally poor, resulting in indeterminable results in most cases. The signal when supine was superior and yielded results in all fields for all but 5 patients. When supine, Ti:Ttot was abnormal in only 1 patient and 1 other patient had an IE50 above the normal range. However, 7 patients exhibited abnormal RTC and 5 patients had an abnormally high Phase Angle.

Conclusions: Generally, work of breathing (Ti:Ttot) and inspiratory/expiratory flow (IE50) was normal in this patient group. However, SLP can detect thoracoabdominal asynchrony and altered thoracic effort in patients with respiratory muscle weakness when supine. Furthermore, SLP is simple and quick to set up and measure unlike other systems (e.g. magnetometry, optoelectronic plethysmography).

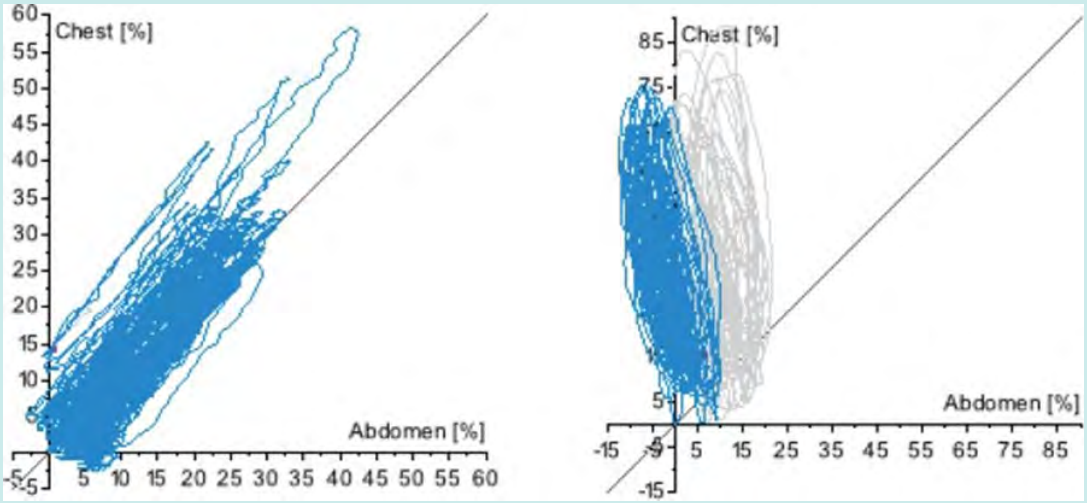

Figure 1: Example Konno-Mead (J Appl Physiol 1967; 22(3): 407-22) plots from a healthy patient with virtually synchronous breathing and a patient with a large degree of thoracoabdominal asynchrony due to respiratory muscle disease (right).

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PD15 DOES THE PLETHYSMOGRAPHIC MANOEUVRE USED TO MEASURE LUNG VOLUMES INFLUENCE RESULTS?

Francis C

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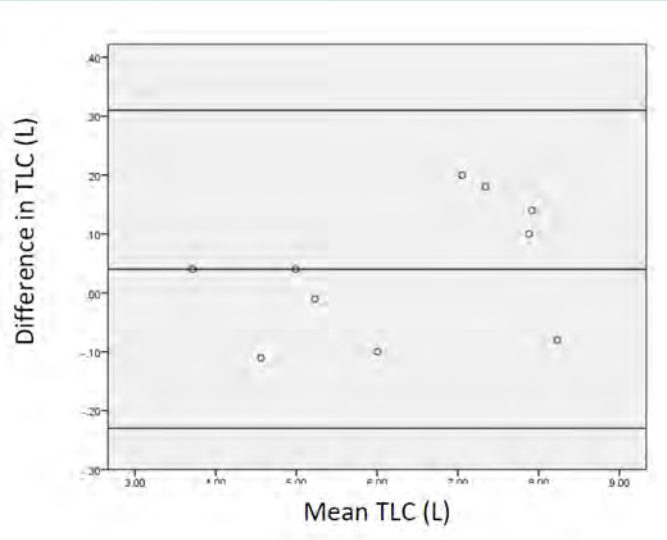
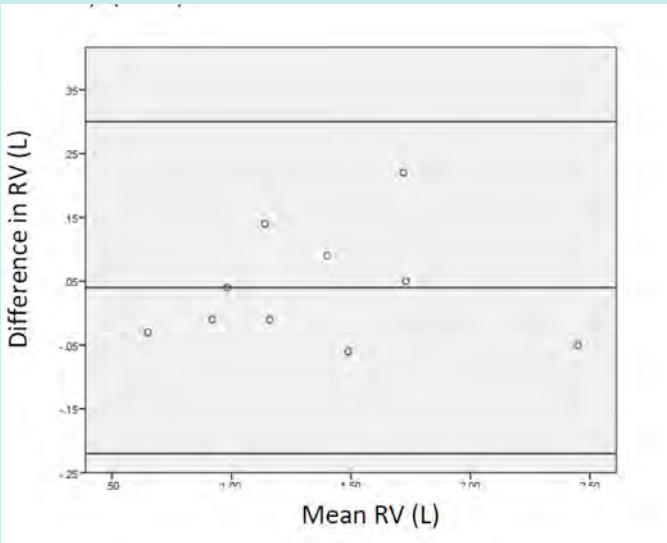
Aim: Body plethysmography is the gold standard method for measuring static lung volumes. The preferred method is for patients to exhale to expiratory reserve volume (ERV) immediately after the shutter and then inhale to total lung capacity (TLC)[1]. However, guidelines state that performing an inspiratory capacity (IC) manoeuvre immediately post shutter and then exhaling to residual volume (RV) is acceptable, particularly in severely breathless patients[1]. The aim of this study was to establish whether there is a difference in lung volumes obtained by the two methods in healthy individuals.

Methods: With hospital R&D approval, lung volume was measured in 10 healthy volunteers (6 male; age 29.6 ± 6.85 years; height 1.73 ± 0.11m) via three IC manoeuvres and three ERV manoeuvres immediately after the shutter in a randomised order. RV was calculated as mean FRC minus mean ERV. TLC was calculated as sum of RV and best VC. Bland-Altman plots2 were used to assess the level of agreement between the two methods. Linear regression was used to identify any significant bias. Data were normally distributed therefore paired t-tests were conducted to determine if there was a significant difference between TLC, RV, FRC or VC via the two methods. Significance was set at $p < 0.05$.

Results: There was no significant difference between IC and ERV methods for resultant TLC (6.27 L vs. 6.31 L $t = 1.12$, $p = 0.291$), RV (1.34 L vs. 1.38 L; $t = 1.33$, $p = 0.215$), FRC (2.93 L vs. 2.90 L; $t = -0.883$, $p = 0.400$) or VC (4.93 L vs. 4.93 L; $t = 0.085$, $p = 0.934$). There was good agreement between both methods for all measured and derived lung volumes (Figure 1) and linear regression showed no evidence of significant bias for any lung volume ($p > 0.05$.





Conclusion: In healthy individuals there is no significant difference between lung volumes calculated after performing an IC or ERV manoeuvre immediately post shutter. This study should be repeated in patients with restrictive and obstructive lung diseases.

References:

1. Wanger J, Clausen JL, Coates A, et al. Standardisation of the measurement of lung volumes. European Respiratory Journal 2005;26 (3):511-22. doi: 10.1183/09031936.05.00035005

2. Bland JM, Altman DG. STATISTICAL METHODS FOR ASSESSING AGREEMENT BETWEEN TWO METHODS OF CLINICAL MEASUREMENT. Lancet 1986;1(8476):307-10.

PD16 ASSESSMENT OF A LOCAL CONTINUOUS POSITIVE PRESSURE (CPAP) DROP IN CLINIC FOR PATIENTS WITH OBSTRUCTIVE SLEEP APNOEA (OSA)

Butler, A. & Lloyd, J. Respiratory & Sleep Investigation Department, Good Hope Hospital, Sutton Coldfield, England

Background: CPAP drop in clinics were initiated at Good Hope Hospital (GHH) in November 2016 to support the rising number of patients on long-term CPAP therapy (>1,200). These clinics were provided to aid patients with treatment issues in a timely manner and to reduce the number of patients attending without appointment.

Aim: To assess the use of the CPAP drop in clinics at GHH and to establish the need for an increase or decrease in the service. To ascertain the primary reasons patients attend this clinic.

Method: A retrospective review of records for the CPAP drop in clinic was performed. Initial analysis of all patients attending the CPAP drop in clinic from its initiation in November 2016 to February 2017 was performed. The number of patients attending each session was recorded, as was their reason for attending (mask, machine or other). More detailed analysis of patients attending between March and May 2017 was performed, including amount of time the patient waited to be seen and the amount of time spent with a physiologist.

Results: 194 patient attendances were recorded within the CPAP drop in clinic since its initiation. 3 visits were excluded due to missing data. Initial analysis showed the average number of patients attending our Tuesday clinic was 3.7 (range 1-9) and in the Friday clinic was 3.1 (range 0-8). 69% of patients attended for mask issues, 27% due to machine issues and 10% for other issues (e.g. obtaining a travel letter/assistance with DVLA forms). Further analysis demonstrated average waiting time was 8.4 minutes (range 0-43) and average time spent with a physiologist was 12.7 minutes for mask issues (range 1-47 minutes), 10.7 minutes for machine issues (range 1-34 minutes) and 19.6 minutes for other issues (range 5-33 minutes). 6 patient's attended twice and 1 patient attended 3 times.

Conclusion: The drop in clinic at GHH is well utilised. The majority of patients attended with mask issues. This seems to have impacted on the number of patients attending without appointment but unfortunately no firm evidence is available to confirm this. Further work is to be undertaken to reduce wait times for patients. A further clinic with booked mask appointments has been added on a Monday.

References: ARTP, (2017) ARTP Standards of Care - Sleep Apnoea Services, accessed 26.09.2017, at http://www.artp.org.uk/en/sleep/sleep-standards/sleep-documents.cfm/Sleep-Services-Standards.

PD17 EFFECTS ON CPAP USE OF ENHANCED TECHNOLOGY IN A UK SLEEP SUPPORT SERVICE

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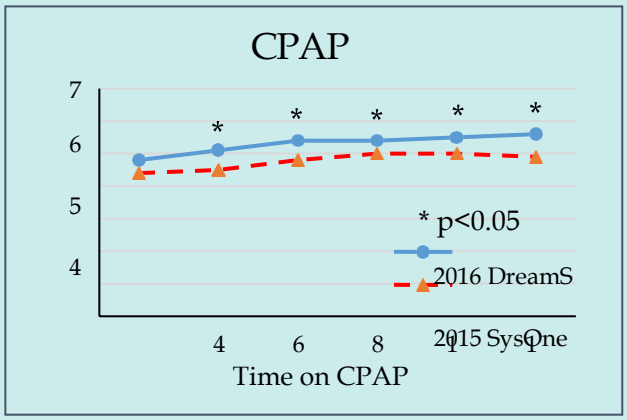
Introduction: Project aim was to audit CPAP use in a sleep support service after implementation of enhanced technology.

Materials & Methods: The audit compared the first 12 weeks' CPAP use in two patient cohorts, one starting CPAP in the 6 months from Sept 2015 (2015) and a later group (2016) the 6 months from Sept 2016. The 2015 cohort were issued System One and the 2016 DreamStation APAP devices (Philips Respironics UK). Between cohorts, remote monitoring through modems was implemented and the DreamMapper patient support mobile app also became available. Both 2015 and 2016 samples were of new CPAP users from two UK sleep centres, with patient therapy co-managed with Philips Sleep Support Service (PSSS). CPAP use (day-by-day) was averaged for 2-week time intervals over the first 12 weeks of CPAP treatment and compared between 2015 and 2016 groups by T-test.

Results: Eligible patients n=881 in total, (n=407 in 2015 and n=474 in 2016 cohorts). CPAP use data were available for 91% of cases at 2 weeks and 81% at 12 weeks. Over the initial 12 weeks (Figure), CPAP use averaged 4.8 ± SD 2.7 hours/night (2015 group) and 5.3± 2.5 hours/night (2016 group). CPAP use was significantly higher in the 2016 (DreamStation) group ($p<0.03$) at all time-points except the first ($p=0.06$).



Average increase in CPAP use with new technology averaged 0.5 hours/night- a 10% gain- and an inter-treatment effect size of ~0.2 SDs.

Conclusions: An audit in a UK sleep service suggested sustained improvements in CPAP use with enhanced technology, with an additional half hrs' usage per nt, similar to findings in a North American study[1]. Future study will seek potential contributants to this from the new therapy device, remote monitoring and patient support app.

References: 1. Hardy et al. DreamMapper: a mobile application and website to engage sleep apnea patients in PAP therapy and adherence to treatment. Philip Respironics

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PD18 A COMPARISON OF THE RESPIRATORY INDUCTIVE PLETHYSMOGRAPHY (RIP) MEASURES AS A SURROGATE TO NASAL FLOW (NF) IN PAEDIATRIC CARDIORESPIRATORY SLEEP STUDIES

Gallagher. A, Russo. K, Laverty. A, Davies. M, Raywood. E, Abel. F Dr.; Respiratory Sleep Unit, Great Ormond Street Hospital for Children NHS Foundation Trust

Introduction: The AASM Manual for the Scoring of Sleep and Associated Events 2012 V2.4[1], advise alternative airflow channels in the absence of the oronasal thermistor and nasal pressure transducer (used to score apnoeas and hypopneas, respectively); the RIP_{flow} and RIP_{sum} channels. This study aims to compare which is the most suitable channel to use for the scoring of respiratory events in Paediatric cardiorespiratory sleep studies.

Methods: 21 patients, 7 each from mild, moderate and severe Obstructive Sleep Apnoea (OSA) study outcomes, based on Obstructive Apnoea Hypopnoea Index (OAHI) were selected randomly from all baseline cardiorespiratory studies recorded within the last 12 months that met specified quality criteria (NF (square root transformation of nasal pressure) present for 100% of the night and an in-house quality rating ='5' (maximum) for the respiratory effort bands). 4 of the studies were discarded as they did not meet the criteria. The existing scored events, the patient name and either the RIP_{flow} or the RIP_{sum} channel was removed randomly and the study was re-scored by a Sleep Physiologist. The process was then repeated with the alternative RIP_{flow} or RIP_{sum} channel present. The original scoring plus the two blinded scoring sessions were then compared for NF, RIP_{flow} and RIP_{sum}. Respiratory events were scored using the current AASM 2012 V2.4 Guidelines[1].

Results: A Wilcoxon signed-rank tests was used to identify differences in AHI, the Obstructive AHI (OAHI), Central AHI (CnAHI) or Unclassified AHI (UAHI) when scored using the Nasal cannula versus RIP_{sum} or RIP_{flow}. (See Table 1.1).

Table 1.1. Sleep study outcomes according to different airflow measures. (Significant at $p<0.05$), n= 17 Sleep Study Outcome	NC Median (IQR)	RIP_{SUM} Median (IQR)	*p**	RIP_{FLOW} Median (IQR)	*p***
AHI	6.30 (4.85,11.85)	6.40 (4.30,12.90)	0.344	6.00 (4.40,12.10)	0.288
OAHI	5.50 (3.55,9.25)	4.90 (3.70,12.05)	0.717	5.50 (2.95,11.15)	0.477
CnAHI	0.30 (0.00,1.80)	0.30 (0.00,0.75)	0.018	0.00 (0.00,0.90)	0.195
UAHI	0.00 (0.00,0.05)	0.10 (0.00, 0.40)	0.959	0.00 (0.00, 0.45)	0.953

Conclusion: There is a good agreement in the sleep scoring outcomes achieved between both alternative RIP measures when scoring cardiorespiratory sleep studies (no significant difference p>0.05). A strong correlation was found between the NF and the RIP measures for obstructive events (less significant for mixed apnoeas); further study is required. There were no central hypopnoeas recorded (however studies were predominantly obstructive) and further study is required to assess whether RIP_{sum} can reliantly be used to score central sleep disordered breathing.

References:

1. Berry RB, Budhiraja R, Gottlieb DJ, et al. Rules for scoring respiratory events in sleep: update of the 2007 AASM manual for the scoring of sleep and associated events. J Clin Sleep Med. 2012;8:597–619

PD19 ASSOCIATION OF SELF-REPORTED DELAYED SLEEP ONSET WITH CPAP FAILURE IN A COHORT OF PATIENTS WITH OBSTRUCTIVE SLEEP APNOEA

Glover, R.J. ; Lloyd, J.K.

Heart of England NHS Foundation Trust United Kingdom ; Good Hope Hospital United Kingdom

Background: Obstructive sleep apnoea (OSA) has been shown to be frequently associated with insomnia and consequently the chances of successful treatment of OSA with CPAP may be reduced in this patient group. Aims: Identify whether self-reported delayed sleep onset, and/or short sleep duration is associated with a higher level of CPAP failure in comparison to individuals without these complaints in the local sleep clinic.

Methods: Data from individuals who experienced CPAP therapy between 1/09/2015, and 2/09/2016 have been retrospectively analysed. Patients are given a standardised questionnaire to complete prior to baseline sleep studies. Question 1 and 2 have been included (Question 1: Do you struggle to get to sleep? 1, Never 2, rarely 3, sometimes 4, frequently; Question 2: how long do you sleep for in a 24 hour period? 1, 4-5 hours, 2, 6-7 hours 3, 8-9 hours 4, >10 hours). The hypothesis is that answer 4 (defined as delayed sleep onset) to question 1, and answer 1 (defined as short sleep duration) to question 2 are independently associated with CPAP failure. The cohort is divided into two groups. Group 1 includes CPAP failure, which is defined as non-concordance at 12-month review or rejection of CPAP following a treatment trial. Group 2 includes individuals concordant with CPAP (4 or more hour's average usage per night) at the 12 month review.

Results: Data from 232 individuals were included in the analysis; 5 sets of data were excluded due to incomplete answers. The unadjusted odds ratio (OR) for patient reported sleep onset delay to have the outcome of CPAP failure was 3.72 (1.96, 7.07) p =<0.001; the adjusted OR was 2.77 (1.31, 5.83) p = 0.007. The unadjusted OR for short sleep duration having the outcome of CPAP failure was 2.14 (1.15, 4.04) p = 0.019; the adjusted OR was 1.41 (0.66, 3.01) p = 0.380.

Conclusion: In the local CPAP clinic, self-reported delayed sleep onset prior to treatment is independently associated with CPAP failure.

References:

1. Luyster F, Buysse D, Strollo P. (2010). J Clin Sleep Med, 6 (2): 196-204
2. Ong J, Crawford M. 2013. Sleep Med Clin, 8 (3): 389-398

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PD20 CASE STUDY: COMPLEX SLEEP APNOEA

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Royal Derby Hospital NHS Trust

A 62 year old male was referred for investigation of possible OSA, complaining of fatigue, unrefreshed sleep, witnessed apnoeas & loud snoring. He was referred for an overnight oximetry test which showed episodic cyclical desaturation with associated HR rises. Showing sats of 96% & ODI of 4.58. The patient presented with daytime sleepiness, witnessed apnoeas and episodes of choking & gasping. He usually slept for 7.5 hours a night waking unrefreshed with morning headaches. He had a history of jerking but no parasomnia, chronic pain due to psorratic arthritis controlled with Baclofen & Morphine. As the ODI was normal with a history convincing of OSA and possible periodic limb movement, he was referred for a limited sleep study test. The limited sleep study showed AHI of 9.7 with 30% of events being central in origin. The patient was set up on CPAP & monitored remotely using tele monitoring. The obstructive apnoeas improved with a CPAP pressure of 8, but the central apnoeas increased (AHI of 18 with a CA of 12 after 3 weeks). The patient continued to complain of significant daytime sleepiness & continued morning headache. Opiate withdrawal was attempted but pain worsened and this approach could not be maintained. An echocardiogram excluded heart failure. Treatment was changed from CPAP to Adaptive Servo Ventilation. The central apnoeas improved significantly (AHI of 2.7) with average nightly usage of 7:30 hrs, daytime sleepiness improved & headaches resolved. He reported a significant improvement to the quality of his life. CSA syndrome is used to describe a type of sleep apnoea where obstructive events are treated with CPAP but where central apnoeas persist or worsen (1). CSA has been shown to occur in 14% of patients receiving acute oral narcotics the use of which can decrease central drive; RR & TV. They can increase airway resistance & decrease patency of the upper airway which may lead to upper airway obstruction (2). Patients with OSA with an element of CSA can often fail CPAP therapy. For these patients who have CSA who fail CPAP therapy more advanced ventilation techniques, such as ASV therapy, can be effective (3). The CS Pacewave ASV device, uses minute ventilation targeted algorithm. It performs breath by breath analysis & alters pressure support accordingly. This case adds to emerging indication for future treatment in such patients.

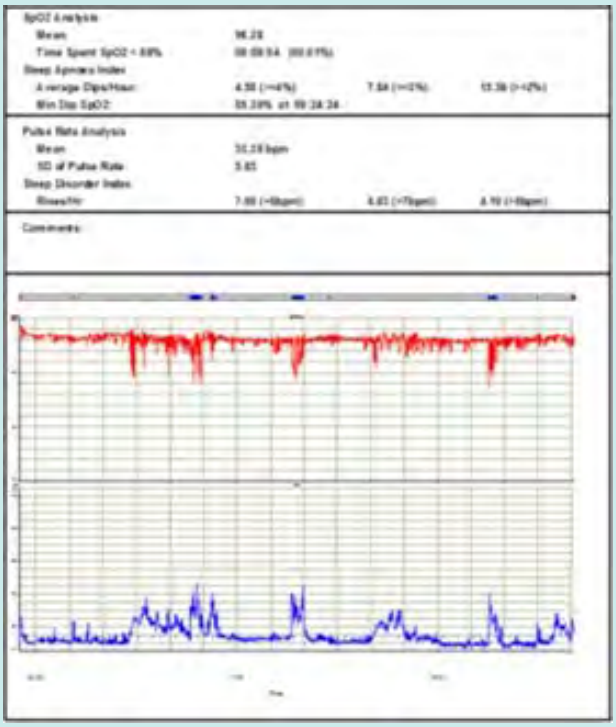

Figure 1. Overnight oximetry

Figure 2. Limited sleep study

References:

1. T. Young et al The occurrence of sleep disordered breathing among middle aged adults. The new England Journal of Medicine. Vol 328 no 17 pp1230-1235, 1993
2. The Effects of Narcotics on Respiratory Physiology: The association of OSA and Chronic pain.
3. Complex sleep apnoea syndrome: Breathe. September 2013, volume 9, No 5, p37

PD21 COMPARISON OF OXYGEN DESATURATION INDEX AND APNOEA-HYPOPNOEA INDEX FOR CATEGORISING OSA IN CHILDREN. Category: A

Dos Santos, C; Laverty, A; Samuels, M MD FRCPCH; Russo, K: Respiratory Sleep Unit, Great Ormond Street Hospital, London, England.

Background: Increased numbers of referrals for cardiorespiratory sleep studies are being received for patients with Ear, Nose and Throat (ENT) conditions without accompanying co-morbidities. The studies are used to diagnose Obstructive Sleep Apnoea (OSA) and thereby to plan management. Performing cardiorespiratory studies on all patients within the necessary timeframe has become difficult. The aim was to assess whether Oxygen Desaturation Index (ODI) could be used as an alternative to Apnoea-Hypopnoea Index (AHI) when determining OSA in this cohort of patients.

Methods: The laboratory database (Microsoft Access) was used to retrieve sleep study data (recorded using Embla S4500 and analysed by trained Respiratory physiologists) for all ENT patients referred from the two most frequent general hospital referrers over the previous 8-months. Data retrieved included: screening questionnaire information, AHI, ODI and study outcome. Both ODI and AHI were ranked for severity of outcome using local severity classification criteria for events or dips/hour: Normal <1; Mild 1-5; Moderate 5-10; Severe >10 and the patients were grouped accordingly.

Results: Data was collected from 154 patients (104 male, 50 female) ranging from 10 months to 15 years (Median 4.29yrs). Results achieved using AHI or ODI to classify OSA severity are displayed in Table 1.

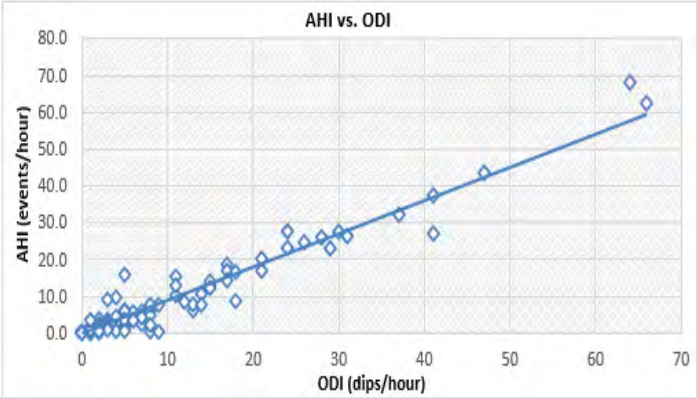

Figure 1: A scatter graph plotting AHI vs. ODI, and the variation from linearity.

ODI Criteria	Frequency	AHI Criteria	Frequency
Normal (<1)	14	Normal (<1)	63
Mild (>0.9, <5.0)	83	Mild (>0.9, <5.0)	50
Moderate (>4.9, <10.0)	26	Moderate (>4.9, <10.0)	14
Severe (>9.9)	31	Severe (>9.9)	27

Table 1: Patients sorted by ODI/AHI severity

Spearman's Rho test showed positive correlation between AHI & ODI [rs=0.862 (p=<0.001)], see Fig 1. For an AHI>1, an ODI>1 had a sensitivity of 100% and a specificity of 22.2%. The area under receiver operator characteristics curve for ODI to predict AHI>1 was 0.892 (95thCI: 0.841- 0.942). Results also show that in 53% of patients, ODI correlated with the correct AHI severity.

Conclusions: The data suggests ODI is not a reliable indicator of AHI severity as calculated by cardiorespiratory studies; ODI is a better indicator of AHI at the more severe levels of SDB. Further statistical analysis to assess appropriate ODI cut-offs will be undertaken.

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PD22 PROVIDING A MORE EFFICENT OBSTRUCTIVE SLEEP APNOEA (OSA) DIAGNOSTIC AND TREATMENT SERVICE FOR PREOPERATIVE PATIENTS.

Goodlad M

UHCW NHS Trust

UHCW NHS Trust has a successful sleep service which assesses, diagnoses, and treats patients with sleep disordered breathing (SDB). Patients are referred to the service from the Coventry and Rugby area as well as neighbouring counties. UHCW NHS Trust is also a tertiary centre for cardiac & thoracic, orthopaedic, and gynaecological surgery as well as providing general surgical services for the local population.

Studies have shown that patients with untreated/ undiagnosed SDB are at an increased risk of perioperative and postoperative complications.[1,2] It is, therefore, imperative to have a diagnosis of OSA prior to surgery, so as part of the pre-operative assessment patients are asked to complete Epworth and STOPBANG questionnaires to assess the risk of the patient having sleep disordered breathing (SDB).

Prior to 1st September 2017 those patients who were considered a high risk of SDB (Epworth Score >11 &/or STOPBANG score >5) had their surgery delayed allowing their General Practitioner (GP) to arrange a referral to a sleep consultant and if appropriate a further referral for a sleep diagnostic tests plus if the test showed significant OSA, starting CPAP treatment. This process was taking many weeks, resulting in delay in surgery, causing emotion stress and worries for the patient and in some cases a deteriorating of the patient's condition.

It was proposed by the Senior Pre-Operative Nurse and the Lead Sleep physiologist that from 1St September 2017 the SDB pathway changed to allow these patients to be referred from the per-operative clinic directly to the Department of Respiratory Physiology and Sleep Department. This would allow patients to be have their sleep study and if relevant, CPAP in a timely manner and it is estimated that 8 weeks will be saved by omitting the need for a GP referral.

This change in pathway is currently in progress and after 3 months an audit will be performed to assess the efficiency of the change including time taken from pre-operative assessment to sleep study and treatment compared with the previous pathway & to review whether this has a positive effect on the reduction of waiting time to surgery.

References:

1. Kaw R, Michota F, Jaffer A, Ghamande S, Auckley D, Golish J. Unrecognized sleep apnea in the surgical patient: implications for the perioperative setting. Chest. 2006;129:198–205. doi:10.1378/ chest.129.1.198.
2. Liao P, Yegneswaran B, Vairavanathan S, Zilberman P, Chung F. Postoperative complications in patients with obstructive sleep apnea: a retrospective matched cohort study. Can J Anaesth. 2009;56:819–28. doi:10.1007/s12630-009-9190-y.

Next stop: Glasgow

ARTP 2019 Glasgow 31st January—1st February 2019

Doubletree by Hilton Glasgow

ARTP are delighted to be bringing the conference north of the border for the first time since 2011. The hotel we have chosen is in the city centre so easy to get to and lots of places to explore in your downtime.

The ARTP Events committee is working hard putting together an exciting educational programme and social events to match so keep an eye on the website for more information. In the meantime click below to watch a short video on just what this amazing city has to offer.

ASSORTED READING

- "Is a cold water swim good for you, or more likely to send you to the bottom?" — http://theconversation.com/is-a-cold-water-swim-good-for-you-or-more-likely-to-send-you-to-the-bottom-89513
- Think twice about buying squashed-faced dog breeds. https://www.theguardian.com/lifeandstyle/2018/jan/05/think-twice-about-buying-squashed-faced-breeds-vets-urge-dog-lovers?CMP=share_btn_link
- Ten principles for climate, environment and respiratory health. http://erj.ersjournals.com/content/50/6/1701912?etoc
- "Why the e-cigarette industry needs global regulations" — http://theconversation.com/why-the-e-cigarette-industry-needs-global-regulations-90830
- "Big Tobacco is funding the anti-smoking lobby – but leaked documents reveal the real reason why" — http://theconversation.com/big-tobacco-is-funding-the-anti-smoking-lobby-but-leaked-documents-reveal-the-real-reason-why-93087
- "Free divers have long defied science – and we still don't really understand how they go so deep" — http://theconversation.com/free-divers-have-long-defied-science-and-we-still-dont-really-understand-how-they-go-so-deep-92690

TOP TWEETS

Asthma + Respiratory @AsthmaFndation Mar 7
An interesting article below about the effects mould can have on your health and what it means for your home. http://ow.ly/TrK430iODLV

BMJ Open Respiratory @BMJOpen_Resp Feb 22
Is childhood wheeze and asthma in Latin America associated with poor hygiene and infection? A systematic review - Introduction High asthma prevalence in Latin-American cities is thought to be caused by poor hygiene

BMJ Open Respiratory @BMJOpen_Resp 18 Dec 2017
Predictive value of prebronchodilator and postbronchodilator spirometry for COPD features and outcomes - Introduction We compared the predictive value of prebronchodilator and postbronchodilator spirometry

ERS publications @ERSpublications Feb 24
The hypercapnic ventilatory response measured by a rebreathing setup is reproducible, as opposed to a steady-state setup http://ow.ly/yGDg30hStIB

Asthma UKVerified account @asthmauk Feb 21
RECALL ALERT: Some Ventolin Accuhaler & Seretide Accuhaler inhalers are being recalled. There's no need to panic - this is a mechanical fault & the medicine in the inhalers hasn't been affected. Here's what you need to know (thread)

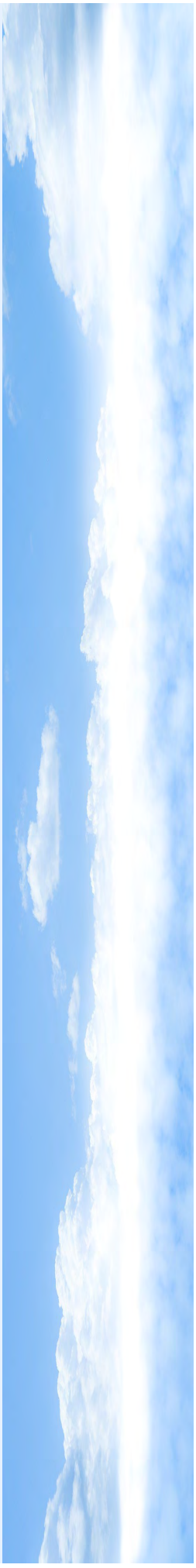
ERS publications @ERSpublications Feb 17
Exhaled nitric oxide and BMI predict accelerated decline in FEV1 in adults with new-onset asthma http://ow.ly/1yDz30hE5YE

By Suhilla Hashimi

James Hull @Breathe_to_win Jan 28
Impact of beetroot juice on FeNO. Do you ask before testing?

FROM THE JOURNALS

- Severe ketorolac-induced asthma diagnosed by chest computed tomographyhttp://jtd.amegroups.com/article/view/17117/html?utm_source=EDM_JTD_ERS_2017
- Lung tissue repair and remodeling in chronic lung diseases: mechanisms and therapeutic approaches" http://jtd.amegroups.com/article/view/17122/html?utm_source=EDM_JTD_ERS_2017
- Insights from the paediatric assembly http://jtd.amegroups.com/article/view/17120/html?utm_source=EDM_JTD_ERS_2017
- Effects of anaesthesia on paediatric lung function https://academic.oup.com/bja/article/117/2/151/2595026
- Viruses causing lower respiratory symptoms in young children: findings from the ORChID birth cohort http://thorax.bmj.com/content/early/2018/01/03/thoraxjnl-2017-210233
- Preschool wheeze, genes and treatment http://www.prrjournal.com/article/S1526-0542%2817%2930113-6/fulltext
- The clinical use of mechanical insufflation-exsufflation in children with neuromuscular disorders in Europe http://www.prrjournal.com/article/S1526-0542%2817%2930096-9/fulltext



ARTP Regional News

Remserve medical Student of the Year Award Winner Heidi Elkington left, with Program Director Nikki Williams

Cara Roderick left, and Yiwen Lee right

January saw the Graduation Ceremony of the Respiratory and Sleep Physiology PTP cohort from Swansea University. This year all four students from the cohort graduate with a BSc (hons) Healthcare Science (Respiratory and Sleep Physiology).

Each year a 'Student of the Year' prize is awarded to one student, taking into account their academic achievement, performance on clinical placement, and contribution towards the programme or profession.

This year's prize, generously sponsored by RemServe Medical Supplies, was awarded to Heidi Elkington. Heidi graduated with a first class honours degree, and throughout the year impressed her Lecturers and Clinical Supervisors from departments around Wales with her enthusiasm and work ethic.

Speaking about Heidi at the award ceremony, Program Director Nikki Williams said she has been *"an excellent student throughout the three year programme and the award of Student of the Year is well-deserved. As usual we have a small but extremely high quality cohort of graduates and I wish them all the very best in their careers in respiratory physiology"*.

Upon receiving the award and prize Heidi said *"I am so grateful for the teaching, support and encouragement of all the departments over the last three years, I really couldn't have wished for any better".*

As with previous years, Heidi, and the other excellent students from her cohort: Rob Cooke, Yiwen Lee, and Cara Roderick had all received job offers before they had completed their studies and are currently working in NHS departments across the UK."

Alex Perkins

Senior Lecturer (Respiratory & Sleep Sciences) | Uwch Darlithydd (Gwyddor Resbiradol a Chwsg)

College of Human and Health Sciences | Coleg y Gwyddorau Dynol ac lechyd

Swansea University | Prifysgol Abertawe

'NO PRIZES' CRYPTIC CROSSWORD

Will be back for the August issue

Answers to 'No Prizes', December 2017 issue:

Across: 3. PNEUMOTACHOGRAPH, 9. WEDGE BELLOWS, 11. LOBE, 12. RIB, 16. PEFR, 17. ALLERGY, 18. STADIOMETER, 19. CHALLENGE, 20. THORAX

Down: 1. PULSE, 2. TURBINE, 4. CAPACITY, 5. PLETHYSMOGRAPHY, 6. FILTER, 7. ENO, 8. FOT, 10. WEIGHT, 13. CARINA, 14. HISTAMINE, 15. HEIGHT

ARTP Association for Respiratory Technology & Physiology