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Association for Respiratory Technology & Physiology

INSPIRE

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First word

Dear Readers,

Welcome to the post-conference edition of *INSPIRE* - and my first as Editor. Aidan Laverty stepped down after ten years at the helm and what a fantastic job he did with the publication. It was quite fitting that he received the ARTP lifetime achievement award at this year's conference. He has been the principal physiologist at Great Ormond Street for many years, doing a fine job of leading one of the UK's top children's hospitals. I first met Aidan in Vienna at the European Respiratory Society congress in 2012 and since then I have had several visits to GOSH to learn various paediatric techniques. In your career, you meet good people who become close friends and Aidan is certainly one of them. I hope I can continue the success of *INSPIRE* as he did.

For this edition, we have the regular '**A Word from the Chair**'; Julie Lloyd; Brendan Cooper has written a very enjoyable article on the history of '**On the Blower**', and ARTP's growing relationship with the manufacturers; the research committee have supplied their '**Fresh Air**' article looking at pulse oximetry to help diagnose obesity hypoventilation; I have picked out my '**Top Forum**' posts from over the last few months; and we have the high quality **abstracts** that were presented at the **Brighton conference** this year.

Special mention must go to all authors who presented at conference this year. The quality of research produced by members always astounds me, and these are showcased excellently by the Events Committee allowing poster sessions their own slot, without other sessions running simultaneously. As always, the ARTP do it the right way!

Finally, I have included **pictures from the conference** and the **AGM minutes** which are always useful to look through if you want to find out what goes on behind the scenes of the ever-moving ARTP.

I plan to introduce a new feature: '**Lab in the Limelight**'. I am keen to tell the story and promote some of the smaller departments from around the country. So, if you are interested in writing a small piece detailing the history, current services and staff then please drop me an email. Additionally, if you have any articles you would like to write for the journal, please let me know. We are always looking for new material and *INSPIRE* is a great vehicle to get your work out there.

I hope you enjoy, and we are able to *INSPIRE* something in you.

Paul Burns

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A Word from the Chair

Julie Lloyd, *ARTP Honorary Chair*

Welcome to a bumper summer edition of *INSPIRE*, and the first edition under our new editor, Paul Burns – it will be exciting to see how Paul develops our ARTP flagship publication over the next few editions and I am sure he will welcome any feedback you have.

I'm sure, like you, I cannot believe that we are over halfway through 2023 – I've no idea where the time has gone, but as the old adage goes 'time flies when you're having fun … or when you work for the NHS'! And talking of time flying, July 5th saw the NHS celebrate its 75th anniversary and despite being once considered an unimaginable concept, the NHS has become an indispensable part of our lives today. It has become an integral part of our society, providing essential healthcare services and embodying the values of compassion, dedication, and excellence that we all demonstrate each day in our roles as respiratory and sleep scientists.

As always, your ARTP committees have been hard at work planning our educational programs and our scientific meetings. On Monday, the ARTP Events Committee met to finalise the program for the ARTP National Strategy day taking place in Birmingham on 17th November 2023. We have an exciting program planned for the senior leaders in lung function and sleep and the even better news is that it continues to be offered at no cost, so heads of service should book their places now. The Events team also drafted the program for our annual conference 2024 in Harrogate next year. This program has been developed based on the feedback from our membership who attended the conference in Brighton this year and hopefully we can deliver a conference with something for everyone.

ARTP has also continued to work on our Equality, Diversity and Inclusion (EDI) policies and we are developing a delivery strategy to embed them into all that we do. Our Workforce Chair, Max Thomas, has completed some survey work around EDI and this has provided an excellent basis for us to continue this important work.

Following the financial challenges of Covid, our financial position has improved of late and this is thanks to the hard work of our Treasurer, Mike Lang and the excellent ongoing support of our Financial Non-Executive Director, Mark Hubbocks. This improved financial position means we are again able to provide a range of bursaries to support our members to attend a range of scientific conferences, so look out for the information on the ARTP website.

Given how packed this edition of *INSPIRE* is, I will keep this 'Word from the Chair' as brief as possible. As always, I look forward to continuing to work with each of you as your Chair and hearing your thoughts, suggestions and comments for the future directions of ARTP. All that remains, is to wish you all a happy and relaxed summer, hopefully the weather will continue to be kind and we can enjoy some more bright and sunny days.

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ON THE BLOWER

Brendan Cooper
Interim MLC Chair

In this edition of 'ON THE BLOWER' we feature an article on a Short history of ARTP Manufacturers' Liaison Committee

In 1993, as a fresh faced Ph.D. graduate with 10 years experience of NHS clinical physiology, I was appointed as head of the lung function and sleep service at Nottingham City Hospital. The previous head of service (now Dr) Sue Revill, who was ARTP Education Chair at the time, asked me to join the ARTP Executive Committee. Well it seemed like a good idea at the time - it was chaired by a certain Dr Sue Hill (whatever happened to her?) and included Angela Evans (Stoke), Pat Mitchell (Liverpool) Steve Scholey (Pontefract), Jane Caldwell (Rotherham)) and many others now long retired. (After a year or so, a certain Julie Lloyd joined the Exec – what happened to her also?)

As an Executive Member without a portfolio, I decided to invent a new role. In 1995, we were struggling financially and I realised that a potential source of income for ARTP could be from the manufacturers who made and supplied the equipment and consumables we all used. They had always been generous to support our then small annual conferences held in hospital education departments or small hotels. I proposed that I would become the Manufacturers' Liaison Officer and head a Manufacturers' Liaison Committee. To my surprise, with one unanimous vote around the table – MLC was born. One of my first actions was to create a regular article in "Breathe", (shortly to evolve in to "Inspire") which became this very article "On the Blower".

(Incidentally, I devised the name "On the Blower" from when as a student I used to work on Saturdays and holidays as a "counter clerk" in a betting office in Liverpool. Whenever a greyhound race was happening, the shop tannoy would blare out via the phone line , "We're on the blower, they're going down at Wolver(hampton)". Naturally, the play on words for spirometers was too easy, so the name was adopted and has stuck for the last 28 years!)

The principal idea was to have the function of the then BBC "Watchdog" where members could contact us if they felt they were getting a raw deal or poor service from companies. Many members complained at the time that certain companies would "fob them off" with "Oh this is the only customer who has this problem". There was no social media then and the ARTP Forum was in its infancy, but some manufacturers forgot that through ARTP conferences and Regional meetings physiologists talked about their equipment and services – both good and bad. Also, often manufacturers wanted to contact their customers rapidly about issues and developments, so it was a two way street, and we all benefited from it. Hence the "ARTP Watchdog" facility was established where anyone can contact ARTP MLC with an issue or problem from either side of the clinical/manufacturer fence.

The aims and purpose of the Manufacturers' Liaison Committee were developed and included the following;

- To support and give a voice to ARTP members with disputes or issues around services, equipment or consumables with manufacturers and/or suppliers.
- To enable and promote fair engagement between manufacturers/suppliers and ARTP members.
- To present a united front of practicing clinical physiologists to discuss issues with manufacturers and suppliers (including service contracts, direct patient sales, training courses, new developments and technology, delays in parts or engineering support).
- To establish a manufacturers annual award scheme at ARTP conference to promote good practice, competitive services and better membership/manufacturer engagement.
- To promote information and knowledge about lung function and sleep equipment to help solve clinical problems and share advice and experience with the membership.
- To share the knowledge and expertise of the manufacturers/developers with the ARTP membership.
- To make manufacturers "partners and stakeholders" in ARTP without bias or favour.
- To use ARTP Forum to ask (usually) balanced unbiased and fair questions about equipment, procurement or unusual errors in diagnostics and treatment.
- To do all of the above with good humour, kindness, fairness and honesty

It has been an interesting journey with fine examples of good working together, good communication and excellent mutual support but also unearthing some poor services, shoddy management, and dreadful communication or disaster recovery episodes. Naturally, politics, world events and time have presented companies with dilemmas, problems and challenges, but very often by working with MLC, members and companies have enabled transitions to new solutions and technologies. We have seen many companies come and go, merge and separate, as well as company advisors, representatives and engineers swap across manufacturers or even return back to clinical service. All very healthy and vibrant for our profession!

The upshot of this has been that there are strong and trusted relationships between industry and clinical teams which means we have the understanding and mutual respect to be able to work together on solving clinical problems and delivering care with the best science and technology we can muster. By using a highly educated, well trained and knowledgeable profession we have ensured standards are maintained and best care is delivered to our patients, by getting the best out of our manufacturers.

Manufacturers' Liaison Officer/Chair	Dates	Notes
Brendan Cooper	1995 – 2000	Member of MLC 1995-2023
Nigel Clayton	2000 – 2016	Established MLC Survey & Awards
Matthew Rutter	2016 – 2023	Modernised MLC
Brendan Cooper	2023 – 2024	Interim Chair

It's fair to say that ARTP MLC hasn't always got it right. Misunderstandings, email threads that said a little bit too much, rapid reactions and "shooting from the hip" on the Forum, have sometimes exacerbated problems or sent companies rushing to their legal departments. These have all been experienced and dealt with over the decades. But like any relationship, it has been better for those challenges and making us change our attitudes and behaviours on both sides of the manufacturer/user divide.

There has also been some good fun and banter across the MLC community. Kevin Hogben (erstwhile of PK Morgan, Morgan Medical, Pulmolink, Medisoft, MedGraphicsUK) is like a national treasure to ARTP (...some say he would best off kept at the bottom of the sea....!). He and I have shared some great banter and ribbing (respiratory term!) and much debate on often recurrent issues – ATPS/BTPS conversion, the nuances of the gas transfer test, body boxes, reference values and inevitably the history of the spirometer since 1874!! However, within the industry and ARTP his knowledge of the physics and physiology is second to none. His encyclopaedic knowledge (and those endless stories of working around the world!), show that as manufacturers and clinical staff we are all actually learning from each other and each make up part of this amazing "ARTP family". There are many other manufacturing colleagues, some who have come from the lung function/ clinical "coal face", who have contributed huge amounts too. We are grateful to them all as there are too many to mention – unless there's time at the Gala Dinner.....!

One of the lighter "complaints" was when ResMed, to celebrate a new CPAP model, did a promotion where they filled old CPAP cases with mint chocolates and sent them to UK customers. As MLC Chair, I contacted Ross Somerville, the UK Head and complained about one of their CPAP machines that didn't work! No sound, no pressure, no display.....just chocolates pouring out of the device! He was apparently asked to leave a Board meeting to talk with me such was my "anger" about the fault.....when the penny dropped! (I got him again 2 years later when they had another promotion giving customers large bars of a famous Swiss chocolate, which was triangular in shape. I had emailed him to say I was irate and we were still awaiting delivery of a component, "Serial number:T0b13R0n3". The penny dropped again. We haven't spoken for many years now.....☺!).

Company heads have generally always had a healthy respect for MLC and know that they can always come to us and highlight where they have been treated unfairly by customers as well. Very often it is down to Trusts not paying their invoices on time that leads to manufacturers not doing anymore work until being paid (not unreasonable). In many ways, MLC has acted as a catalyst and enabled reactions to happen more easily.

Indeed, out of both ARTP Sleep and ARTP MLC, in 2008 the ARTP Sleep Apnoea Consortium (SAC) was formed which acts in part as an extension of MLC around sleep issues. It has a much stronger patient/user focus but often engages with the same manufacturers across the table. Having already established that MLC relationship, it has been much easier to work with them in the SAC. This has been especially true given the recent issues over global CPAP supplies.

In my role as President of AHCS, I have attended numerous HCS professional body dinners and exhibitions over the years. Whilst they have excellent exhibitions and sponsored events, I have yet to find the unique relationship between members and manufacturers that ARTP has developed through MLC. This has been further confirmed by Dr Martin Allen, NHSE Physiology Lead who has tried to find out about the relationships between the physiologies and the manufacturers they work with. He has been unable to find anything like ARTP MLC, the annual awards and the benefits of this appropriate working partnership. This is something special which we need to nurture and develop for the future.

I am delighted to return temporarily to leading MLC as it transitions to its next era.

I'm pleased to announce the new Committee members we now have on board and their remits as follows:

ARTP MLC 2023

Brendan Cooper	*(Interim MLC Chair)*
Matt Rutter	*(Past MLC Chair)*
Daniel Hutchings	*(MLC Deputy Chair)*
Julie Lloyd	*(ARTP Chair)*
Danny Pender	*(Member: Sustainability role)*
Karamo Cham	*(Member: Buyers' guide)*
Ian Cliff	*(Member: Standards issues)*
Karl Sylvester	*(Member: European/international issues)*
Jo Purvis	*(Member: Lung Function issues)*
Jessica Swan	*(Member: Sleep issues)*

With this great team we would like to develop their leadership skills and deliver some key developments going forward. We have proposed the following developments in conjunction with our manufacturer colleagues:

MLC Projects 2023

1. Prepare future structure and succession planning of roles for MLC: MLC Chair, MLC Deputy Chair, MLC Secretary.
2. Establish, Develop and Publish "ARTP Buyers' Guide" on ARTP Website.
3. Manage current complaints
4. Maintain connections with ARTP Groups including: Standards, ARTP Sleep/SAC, Spirometry, etc.
5. Deliver 2-3 MLC meetings/year with manufacturers

Finally, there have been many ARTP members over the last nearly 30 years who have served on ARTP MLC and contributed vast amounts to its success. It would be remiss of me not to mention Alan Moore, who has teetered in the netherworld of industry and clinical life to bring us stories, challenges, information, knowledge, company insights, and excellent developments in respiratory physiology services. It is useful to have physiologists who act as advisors and confidants to industry to help understand where markets are going, what threats to services may be coming and news of what's going on generally in the lung function and sleep world. I am grateful for his contributions and hard work both on MLC and in the Sleep Apnoea Consortium.

ARTP Manufacturers' Liaison Committee is now in its prime, and we look to you, the members and the manufacturers, to help it grow into a wild and measured old age. Use it, support it and contribute to it. It is a very unique facility, it's very special and it's yours!

ON THE BLOWER *extra*

KoKo pops up again?

MLC have been supporting ARTP members who have had difficulties getting adequate service callouts from KoKo for their full lung function testing kits. It's unusual for OTB to mention these negotiations that usually go on in the background, but the company has been difficult to contact recently and improvements have been slow and not to their customers' satisfaction. We previously published a bulletin from KoKo in OTB, but it is ARTP MLC's belief that the company could try harder with customers and improve communications. We look forward to some positive engagement with KoKo senior management in due course. KoKo customers are welcome to continue informing MLC of any inadequate services that they are receiving. MLC will continue to coordinate customers' issues in a collective approach to encourage better responses from the company as we've always done in the past.

MedGraphics display new role

Nick Chapman at MGC has informed MLC that they are now to supply the Fenom Pro FeNO Device and consumables for the UK.

He has informed customers of this FeNO device, that the original manufacturer of this device is owned by the same umbrella company (NGK the spark plug people!) that MGC Diagnostics now falls under. As such, MGC UK have been asked to assist the UK installed customer base by making the test kits available again from a UK supplier.

They are letting ARTP members know this so anybody that has any concerns will be updated by manufacturers liaison on the plan going forward that will keep their Fenom Pro FeNO Device running. MGC are working on getting stock into the UK as quickly as possible.

Buyers: be aware

Finally, ARTP MLC are planning our next internal meeting in the coming months and high on the agenda is the rejuvenation of a respiratory physiology "Buyer's Guide". Please contact MLC via the website with your ideas for what you would like to be covered in the buyer's guide.

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FRESH AIR

Edited by **Dr James Stockley** *ARTP Chair of Research and Innovation*

Dear Reader,

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

For this issue, Danny Pender has provided an original research article exploring the utility of the time below 90% SpO_2 during limited sleep study as a potential marker of obesity hypoventilation. Danny is a Respiratory & Sleep Clinical Scientist at New Cross Hospital Wolverhampton and has been a member of the ARTP Research and Innovation Committee for nearly two years.

Time Spent Below 90% SpO_2 (T-90) on a Limited Sleep Study (LSS): A Useful Indicator for Obesity Hypoventilation Syndrome (OHS) or a Red Herring?

Danny Pender *Respiratory and Sleep Clinical Scientist, Wolverhampton Respiratory Centre, New Cross Hospital, Wolverhampton*

Introduction

The obesity epidemic is an existential threat to the National Health Service (NHS). A combination and interaction of genetic and environmental factors affecting individuals' energy homeostasis has resulted in nearly two-thirds of adults in the UK being overweight (Body Mass Index (BMI) 25-30kg/m^2) or obese (BMI >30kg/m^2). Simulation models project there to be 11 million more obese adults in the UK by 2030 (Wang *et al*., 2011). Obesity is associated with several comorbidities, including cardiovascular and metabolic pathology and cancer (Apovian, 2016). Furthermore, there is a direct correlation between obesity and sleep disordered breathing (SDB), notably the subtypes of obstructive sleep apnoea hypopnea syndrome (OSAHS) and obesity hypoventilation syndrome (OHS) (Crummy, Piper and Naughton, 2008).

Obesity is often associated with excessive adipose tissue deposition around the upper airway (UA) (increased neck circumference) as well as in anatomical structures within the UA, such as, the tongue (Onat *et al*., 2009 & Kim *et al*., 2014). This is important, as the oropharynx region of the upper airways is uniquely structured to allow for flexibility of movement during wakefulness. However, this predisposes the area to narrowing (hypopnoea) and/or collapse (apnoea) during periods of reduced muscle innovation/tonic input whilst asleep. This is best visualised by the 'Starling resistor model' (Figure 1).

If the tissue pressure (Pcrit) exceeds intraluminal pressure, hypopnoeas and/or apnoeas will occur. Altered airway patency reduces airflow and, thus, results in a decline in haemoglobin oxygen saturation. A feedback mechanism is then prompted by chemoreceptors to stimulate sympathetic nervous system activation, increasing cortical activity to restore airway patency. This process is repeated multiple times throughout the night resulting in periods of transient

FRESH AIR

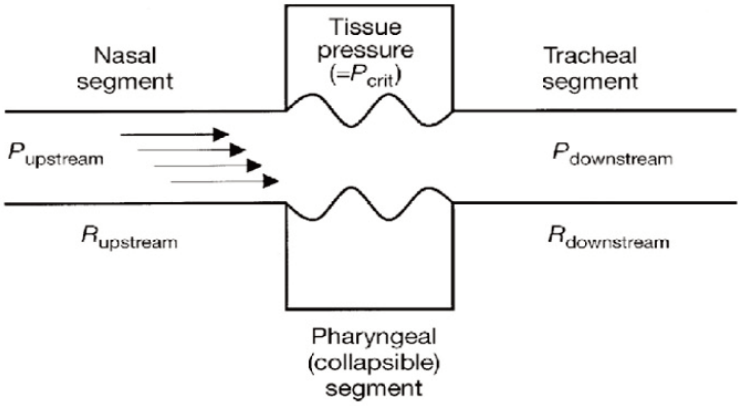

Figure 1. The Starling resistor model of upper airway in obstructive sleep apnoea (Shusterman et al., 2017).

hypoxaemia. A patient is deemed to have OSAHS if the number of airway events is >5 per hour in the presence of excessive daytime sleepiness (EDS)/hypersomnolence (NICE, 2021).

Obesity, particularly centralised obesity (android distribution of adipose tissue around/in the rib cage, abdomen, and visceral cavity) is also associated with numerous mechanical and neural alterations to respiration and is exponentially related to BMI. Change in the respiratory physiological parameters include abnormalities in; functional residual capacity (FRC), expiratory reserve volume (ERV), compliance, expiratory flow, resistance, reactance, and airway closure (Salome, King, & Berend, 2010),- all of which result in an extrathoracic restrictive ventilatory defect.

The above changes are exaggerated in the supine position, with a low ERV and closure of airways in the dependent zones of the lung contributing to ventilation/perfusion inequalities (V/Q mismatch). Furthermore, since tidal breathing occurs at a lower FRC and, thus, in a less compliant portion of the pressure–volume curve, increased effort is required to overcome pulmonary elasticity resulting in an increased work of breathing (WOB) (Parameswaran, 2006). Additionally, increased expiratory flow limitation may promote the development of intrinsic positive end expiratory pressure (PEEPi). To overcome PEEPi, increased respiratory muscle activation is required in order to generate inspiratory flow, further increasing the WOB (Steier *et al*., 2009 & Lin and Lin, 2012). OHS is defined as a combination of obesity (BMI >30kg/m^2), persistent daytime hypercapnia ($PaCO_2$ >6kPa) and sleep disordered breathing, after ruling out other disorders that may cause alveolar hypoventilation (i.e. neuromuscular, mechanical or metabolic explanation for hypoventilation) (NICE, 2021).

The mechanisms and causes of OSAHS and OHS may exist in isolation or in combination. A key distinguishing factor is the presence of eucapnia ($PaCO_2$ 4.6-6.0kPa) and hypercapnia ($PaCO_2$ >6kPa), respectively. In 2016/17, 617,000 admissions to NHS hospitals recorded obesity as a primary or secondary diagnosis (Masa *et al*., 2019). Unfortunately, both OSAHS and OHS are profoundly underrecognised and underdiagnosed, with the latter commonly being identified during an acute-on-chronic type 2 respiratory failure (T2RF) admission when arterial or capillary blood gas analysis (CBG) is performed in a ward setting. In an outpatient clinical setting, OSAHS is routinely diagnosed efficiently, economically, and accurately utilising a diagnostic sleep study in the form of a multichannel/limited sleep study (LSS). However, OHS may still go underdiagnosed, potentially due to limited access to the gold standard of an early morning CBG or the alternative of transcutaneous CO_2 monitoring ($TcCO_2$). The former should be performed during 'early morning' times due to the effect increased daytime ventilation has on $PaCO_2$ and bicarbonate (>27mmol/L

suggestive of OHS). Therefore, it has been hypothesised that spending an increased percentage of time below 90% SpO_2 (T-90) during a LSS may be suggestive of OHS (NICE2021) and this warrants further investigation. Frequent desaturations in OSAHS will ultimately lead to an increased T-90. The sensitivity and specificity of T-90's ability to predict OHS is however yet to be conclusively determined.

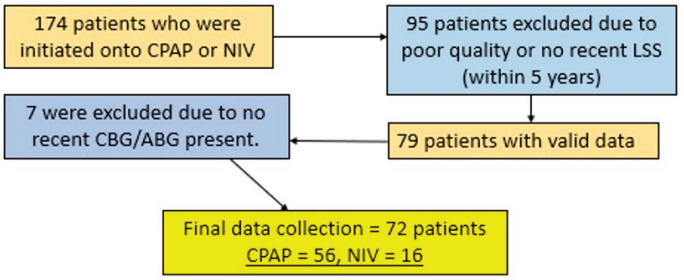

Figure 2. Flow diagram depicting the inclusion and exclusion of patients.

Study aims

Determine the sensitivity and specificity of a ≥30% threshold T-90 during an LSS and its applicability in establishing the appropriate treatment modality, which would either be Continuous Positive Airway Pressure (CPAP) or Non-Invasive Ventilation (NIV).

Study Design

A retrospective quantitative clinical audit was initiated between the dates of October 2022 to January 2023 as part of an undergraduate dissertation project. Inclusion and exclusion flow diagram is depicted in Figure 2.

Statistical analysis

Statistical analysis was performed on SPSS:

1. Linear Regression of the two variables (to determine if 'T-90' can predict a raised $PaCO_2$), coupled with tests of normality.
2. Correlation (to determine if there is a relationship between variables). A non-parametric test was performed. The chosen test was the Spearman's rank-order correlation due to the data not being normally distributed.
3. Receiver operating characteristic (ROC) curve (to determine the sensitivity and specificity of T-90 as a diagnostic tool).

Results

To determine if a linear relationship exists, a scatterplot of the two variables ($PaCO_2$ and T-90) was created, coupled with tests of normality. The scatterplot (Figure 3) was non-linear, as assessed by visual inspection and there were subjects who were not hypercapnic but had high T-90 and subjects who had low T-90 but were hypercapnic. Furthermore, both variables were not normally distributed, as assessed and confirmed by Shapiro-Wilk's test of normality ($p = 0.006$).

The correlation coefficient calculated using the Spearman's correlation, which assesses the strength and direction of the association/ relationship between two variables, shows a significant but weak correlation between T-90 and $PaCO_2$ ($rs = 0.300$, $p = 0.014$).

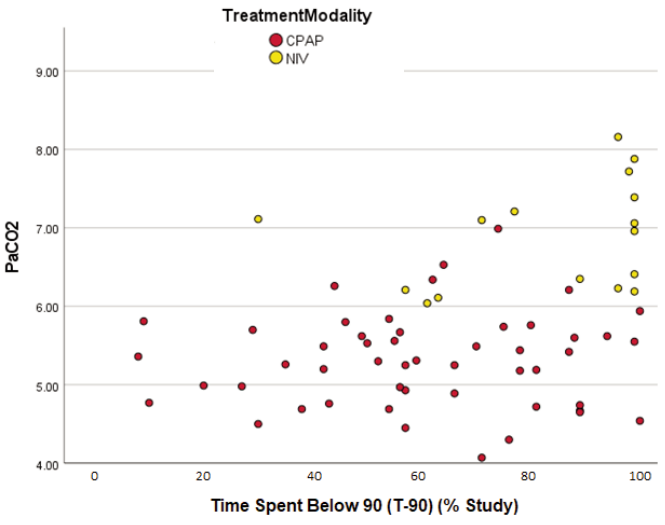

Figure 3. Scatter plot of PaCO2 compared to T-90 (n=72), highlighting a non-linear pattern (rs = 0.300, p = 0.014).

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The coefficient of determination (R^2) value of 0.121 or 12.1% represents the percentage of variance in the dependent variable (T-90) that can be explained by the independent variable ($PaCO_2$). The adjusted R^2 value (which corrects positive bias to provide a value that would be expected in the population) was 0.107 or 10.7%, suggesting that in only a small proportion of cases could T-90 accurately predict an elevated $PaCO_2$.

To determine the sensitivity and specificity of T-90's ability to accurately determine the presence of a raised $PaCO_2$ (hypercapnia), a receiver operating characteristic (ROC) curve was produced (Figure 4). The graph shows an extremely poor ability of T-90 to correctly determine hypercapnia (as demonstrated by the low sensitivity (0.55) and specificity (0.54)). The area under the curve (AUC) was 0.1, where an AUC < 0.5 represents an extremely poor model and is essentially equivalent to a randomised model.

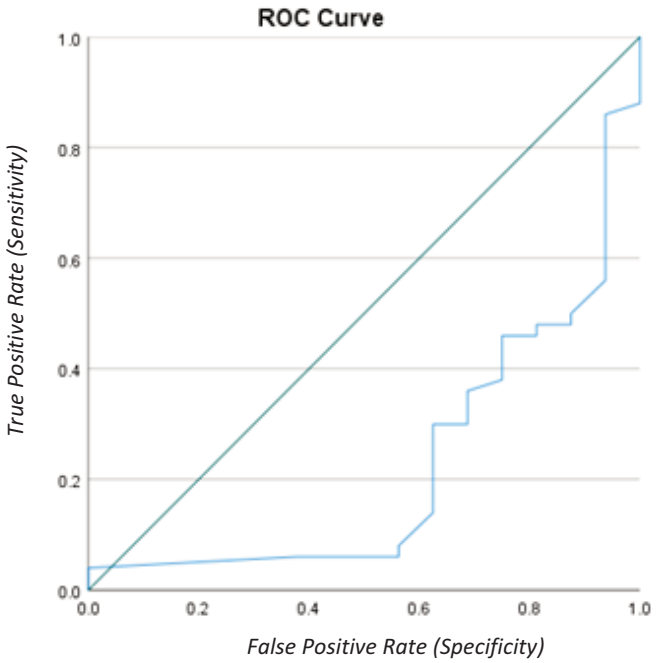

Figure 4. ROC for T-90 in predicting hypercapnia, which was poor with both a low sensitivity (true positive) of 0.55 and low specificity (true negative) of 0.54. As a reference, random classifiers are expected to produce points along the diagonal reference line where the false positive rate (FPR) equals the true positive rate (TPR). The closer the curve comes to the 45-degree diagonal of the ROC space, the less accurate the test- with results below the line having no predictive value.

Summary

The results of this retrospective quantitative clinical audit highlight that, based on the study cohort, T-90 cannot be used as a reliable predictor of a raised $PaCO_2$ and, thus, is not useful in detecting the presence of OHS.

The study in question adhered to rigorous quality assurance guidelines – American Academy of Sleep Medicine (AASM) – with regards to the accuracy and acceptability of LSS. In light of time constraints imposed for an undergraduate research project, a sufficient quantity of patients was assessed to provide an adequately powered study coupled with a wide spectrum of values for T-90 and $PaCO_2$. There was a bias towards CPAP patients (56 CPAP and 16 NIV); however, this may be related to a pathological trend and not selection bias.

The study failed to document the time of sample for CBGs. This is important, as highlighted previously, because regular daytime ventilation normalises/reduces $PaCO_2$. To overcome this, $TcCO_2$ monitoring should be simultaneously performed to highlight any anomalies/outliers. Furthermore, due to the night-to-night variability in physiological parameters in patients with SDB (Stöberl *et al.*, 2017), utilising a multi-night study with an average T-90 and $PaCO_2$ would help improve the accuracy and reliability of the results; this may not be clinically practical in a non-research setting.

Further multicentre prospective research with a larger cohort of patients may be required to scrutinise T-90 and its applicability in predicting OHS in more depth. Moreover, future research should consider the effects of a raised bicarbonate >27mmol, in the presence of normocapnia, and the effects that the recommended treatment modalities have on this physiological variable.

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www.nice.org.uk. (n.d.). Terms used in this guideline | Obstructive sleep apnoea/hypopnoea syndrome and obesity hypoventilation syndrome in over 16s 2021 | Guidance | NICE. [online] Available at: https://www.nice.org.uk/guidance/ng202/chapter/terms-used-in-this-guideline#sleep-study.

TOP FORUM

BEST OF THE ARTP FORUM

Summarising the most popular ARTP Forum topics since the previous *INSPIRE*.

Title: In-flight O_2 policy and hypoxic challenge testing on NIV

Question: It was raised that a respiratory nurse specialist had informed a physiologist that regulations for in-flight oxygen had changed and patients would have to pay in the region of £1000 with some airlines to fly with oxygen. She was wondering if this was the case, and if so could patients who are on NIV have a HCT on their treatment and negate the need for in-flight oxygen. She specifically asked about using a special gas mix cylinder and entraining it through the NIV.

Replies: The first reply was short and gave order details of a special gas mix cylinder which has 15% O_2 with a N_2 balance. The next reply questioned the information from the respiratory nurse and noted that most airlines have their own policy with some charging to use their oxygen and some asking you to bring on a portable oxygen concentrator. He also noted that it was good advice to get the patient to check with the airline prior to booking flights as they would need to take any additional costs associated with in-flight O_2 when deciding who to fly with. Advice was also given on performing the HCT via the body plethysmograph therefore negating the need for a special gas mix cylinder.

Title: Discard and sample volumes for DLCO in Mounier-Kuhn syndrome

Question: This post was asking about the potential to increase the discard volume for the test to levels outside the current guidance due to the inability to see an alveolar plateau in a patient with Mounier-Kuhn syndrome (tracheobronchomegaly). A screen shot of the D_{LCO} test was uploaded showing no alveolar plateau despite a discard volume of 2.19 litres! The results showed a significantly reduced D_{LCO} and K_{CO} which were not in keeping with the symptoms.

Replies: First to post an answer was our national transfer factor expert. He attached a very useful paper on a case report of the condition which also had PFT results. He also informed the physiologist that they would need to measure the actual anatomical dead space (which can be done using the Fowler method). Another reply had looked at the screenshot provided in detail and had noticed a deflection in the expired gas concentrations trace which he thought may indicate a change from the conducting airways.

Title: GLI race neutral reference equations and a potential national strategy day topic

Question: One of the members noted that the ATS had officially released their paper/ statement on the use of race neutral reference equations for spirometry. He described uncertainty as whether to switch to using these and asked if the ARTP could include this as a topic at the national strategy day or perhaps a webinar. He rightly stated that this will potentially have a big impact on our services and also pointed out that it will no doubt be a big topic at this year's ERS.

Replies: One of our prominent ARTP figures replied to say that it could be an ideal opportunity to discuss this at NSD and she may know the person for the job! There was a reply in the format of a question asking if gender neutral reference equations would ever be considered? Another reply noted that this is a controversial subject and made

the point of not sacrificing good science and interpretative accuracy at the expense of inclusivity and that thoughtful and honest discussion were required to reach a balanced resolution. One of our manufacturer clinical specialists raised the point that the old guidance corrected the values by multiplying by 0.9 for non-Caucasian subjects therefore we have already made moves to correct reference data. He also noted about the awareness of pollution effects in relation to reference data.

Title: AAA query contraindication?

Question: The old AAA question reared its ugly head again. This is a common theme on the forum but an important question for newer members, nevertheless. The question was asked about the safety of performing spirometry on a 7cm AAA. She had been asked to do so by one of her consultants and noted she was based in a primary care setting and wondered if there was a specific protocol for testing this type of patient?

Replies: One of our spirometry experts replied to say it was safe and indicated to check if it was going to help make a clinical judgement on whether surgery is safe or not. He made the point that patients continue to cough and sneeze whilst they have the aneurysm, and these generate similar pressure to performing forced spirometry. He also noted that it has been shown that even CPET is relatively safe in these patients but made the all important point that the reason for the test has to justify any risk.

Title: Spirometry calibration syringe verification guidance

Question: One of the members who is based in South Africa (ARTP are far reaching!) was querying the timescale for getting spirometry syringes checked as the ATS/ERS, ARTP and South African Thoracic Society had slightly different recommendations and references for these. She was specifically looking for the guidance documents used by the manufacturer in relation to time intervals and recalibration of syringes. Also a SOP for the verification of accuracy and precision of syringes that is carried out by the manufacturers.

Replies: One of our members who has been involved in the publication of spirometry standards pointed her to the 2019 ATS/ERS technical standard document as being the "gold standard" for quality control in spirometry and specifically a table within the document which details equipment quality assurance for volume and flow measuring devices.

Title: Back to basics – Reasons for VA being considerably smaller than TLC

Question: This forum user was looking for some reasons why VA measured via the single breath fast gas transfer factor test would be considerably smaller than TLC measured via helium dilution in the absence of obstructive spirometry.

Replies: The first reply suggested that alcohol in the breath could be one cause as the fast gas analyser will read this as methane. This could potentially cause a lower VA due to the methane in the exhaled breath being overestimated. Some more replies asked about equipment and specific values from the test. The conversation regarding alcohol affecting the measurement was ongoing between several of the forum members. The post culminated with one of our experts contacting the "guru" of D_{LCO}, Professor Brian Graham, to get his take on it all. He shared Professor Graham's reply which summarised that older gas analysers were more susceptible to issues of interference but this can still be an issue with some newer systems. He talked about the standards document giving instructions on how to compensate for the calculation of V_A and D_{LCO} if the end expiratory gas concentrations were raised. He also noted that future ATS/ERS standards may need to be more explicit around this issue and what is required. Interesting stuff!

ARTP CONFERENCE 2023
Brighton Metropole

Accepted abstracts

P = Poster, O = Oral

P1 Increasing the flow of 100% Nitrogen to improve the accuracy of the Venturi Hypoxic Challenge Test

Mr Harry Griffin[1], Dr Harry Griffin[1]

[1] Hampshire Hospitals NHS Foundation Trust, Winchester, United Kingdom

P2 Longitudinal comparison of hospitalised patients with and without COVID-19 related residual lung abnormalities

Miss Demi Jakymelen[1], Mr Ian Smith[2], Dr Laura Saunders[1], Dr Laurie Smith[1], Dr Roger Thompson[2], Professor Jim Wild[1]

[1] University of Sheffield, Sheffield, United Kingdom, [2] Sheffield Teaching Hospitals, Sheffield

P3 Longitudinal lung function trajectories in adults with severe asthma

Mr Samuel Wallbanks[1], Mr Max Thomas[1], Mr David McNulty[1], Professor Brendan Cooper[1], Professor Adel Mansur[1]

[1]University Hospitals Birmingham, United Kingdom

P4 The effect of breathing pattern on airway resistance and reactance using forced oscillation technique (FOT)

Mr Mark Howlett-Foster[1], Miss Ella O'neill[1], Dr Karl Sylvester[1]

[1] Cambridge University Hospitals NHS Foundation Trust, Cambridge, United Kingdom

P5 Predictors of response to anti-IL-5 biologics in the Birmingham Regional Severe Asthma Service (BRSAS)

Mr Samuel Wallbanks[1], Mr Maximillian Thomas[1], Professor Brendan Cooper[1], Mr David McNulty[1], Professor Adel Mansur[1]

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P6 How sensitive are reversibility criteria in paediatric and adult asthma?

Mr Samuel Wallbanks[1], Mr Paul Burns[2], Mr Max Thomas[1]

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P7 The Inspired Sinewave Test (IST): A New Method to Assess Lung Volume and Ventilatory Heterogeneity

Ms Suzanne Taylor[1], Dr Minh Tran[2], Dr Caroline Jolley[1], Prof. Mona Bafadhel[1], Prof. Andrew Farmery[2], Dr Phi Phan[2], Dr Richard Bruce[1]

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P8 Implementation of a new asthma diagnostic pathway in an acute hospital trust

Mrs Carla Thomson[1], Mr Mark Hardyman[1], Miss Tasmin Sharley[1]

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P9 Analysis of the ATS/ERS 2019 FIVC criterion in COPD patients.

Mr Anthony Dean[1], James Dean[1,2], Dave Singh[1,2]

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P10 Is heart rate recovery an accurate predictor of postoperative mortality?

Mr Joshua Hayter[1], Miss Jade Aston[1]

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P11 Assessing the impact of COVID-19 on patient breathlessness and sleep quality in community settings.

Mr Henry Hodgkins[1], Dr Mark Faghy[2], Dr Tom Madden-Wilkinson[3], Miss Rebecca Owen[2], Dr Ash Willmott[1]

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P12 Home spirometry to titrate and monitor treatment in a patient with sarcoidosis

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Accepted abstracts

P = Poster, O = Oral

P13 Lung function improvement in a patient with cystic fibrosis and advanced lung disease after commencement of Elexacaftor- Tezacaftor-Ivacaftor

Mr Bryn Williams[1], Miss Kate Donovan[1], Dr Dorothy Grogono[1], Dr Karl Sylvester[1]

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P14 Quality and adherence of home spirometry in a remote respiratory physiologist-led assessment

Mrs Megan Robshaw[1], Ms Emma Raywood[1], Mrs Helen Parrott[1], Ms Charmaine Amin[2], Ms Katie Collins[2]

[1] NuvoAir, United Kingdom, [2] Wirral University Teaching Hospital NHS Foundation Trust, United Kingdom

P15 Case study: Pectus Excavatum: Is surgery more than just cosmetic?

Mrs Devra Hepple[1], Mr Christopher Satur[1], Dr Ian Cliff[1]

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P16 Role of home spirometry post the COVID-19 pandemic

Miss Charlotte Richardson[1], Miss Natalie Orr[1], Mrs Sarah Ollosson[1]

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P17 Are all upper airway symptoms due to inducible laryngeal obstruction?

Miss Catherine Dixon[1], **Emma Buckroyd**[1]

[1] North Bristol NHS Trust, Bristol, United Kingdom

P18 Evaluation of pulmonary function test frequency in Interstitial Lung Disease (ILD)

Mr Calvin Apen[1], Mr Muhammad Khan[1]

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P19 A curious example of NIV exacerbating acute on chronic hypercapnic respiratory failure

Mr Dan Hutchings[1], Mrs Helen Purcell[1], Dr Sam Clark[1], Dr Rónan Astin[1]

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P20 The establishment of a website for lung function laboratory document management

Mr Aidan Laverty[1], Ms Kirstie Rogers[1], Mr Elliott D'Souza[1]

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P21 Has the Introduction of the GLI Spirometry Reference Equations Significantly Changed the Predicted Values for ILD Patients at Glenfield Hospital?

Miss Eleanor Davies[1]

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P22 Diagnostic utility of Cardiopulmonary Exercise Test (CPET) in patients with unexplained breathlessness

Mr Christopher Harding[1]

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P23 Cardiopulmonary exercise testing (CPET) and N-terminal pro-brain natriuretic peptide (NTproBNP) testing in the assessment of heart failure.

Mr Adam Rathbone[1], Mr Nigel Clayton[1], Prof. Sonia Correa-Muller[2]

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P24 Assessment of Obstructive Sleep Apnoea with Peripheral Arterial Tone (PAT) Technology

Miss Ketanya Mckoy[1], Dr James Stockley[1], Prof Brendan Cooper[1]

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P25 The impact of not starting therapy in clinic during CPAP initialisation: a retrospective cohort study

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Accepted abstracts

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P26 Change in lung clearance index (LCI2.5) following initiation of Elexacaftor/Tezacaftor/Ivacaftor (ETI) in children with Cystic Fibrosis (CF) aged 6-11 years

Mrs Jody Jolly[1]

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P27 The Oxygen pulse response during cardiopulmonary exercise testing in our paediatric cystic fibrosis population.

Mrs Colleen Carden[1], Mr Paul Burns[1], Mr Scott Tart[1], Dr Ross Langley[1], Dr Philip Davies[1]

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P28 Assessing sub-maximal exercise in Congenital Central Hypoventilation Syndrome

Mrs Kirstie Rogers[1], Miss Mollie Riley[1], Dr Martin Samuels[1]

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P29 Preoperative risk stratification – can we simply our approach to CPETs?

Miss Jade Aston[1]

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P30 Inpatient lung function; timeliness and use in acute neuromuscular respiratory insufficiency

Mrs Vicky Moore1, Mrs Elizabeth Green, Mr Samuel Wallbanks, Dr Rahul Mukherjee

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P31 A Service Evaluation Comparing the 'Spiro-bank Smart' Handheld Spirometer Versus the 'Vyntus SPIRO' Laboratory-Based Spirometer in Paediatric Cystic Fibrosis Patients

Mrs Kellie Moffat[1], Dr Kenneth Macleod[1], Mrs Sarah Blacklock[1]

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P32 Transition to a Physiologist led Cardiopulmonary Exercise Testing (CPET) Service and evaluation of one year outcomes

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P33 The Lung Clearance Index Core Facility

Miss Sophie Pinnell[1,2,3], Ms Mary Abkir[1,2,3], Mr Christopher Short[1,2,3], Ms Clare Saunders[1,2,3], Professor Jane Davies[1,2,3]

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P34 The importance of cardiopulmonary exercise testing reference values in heart transplantation assessments

Mr Joshua Barnes[1], **Miss Holly Le-Winton**[1], Miss Kate Donovan[1], Dr Karl Sylvester[1]

[1] Royal Papworth Hospital NHS Foundation Trust, Cambridge, United Kingdom

P35 Quality assurance of spirometry performed by non-physiologists in a respiratory outpatients clinic

Mr Joshua Edwards[1], Mrs Lauren Lear[1], Dr Julian Ting[1], Mr Richard Madeley[1], Dr Paula Simpkin[2], Dr Karen Stanley[2]

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P36 A collaboration between primary and secondary care: embracing new technology to achieve good quality spirometry

Mrs Lauren Lear[1], Mr Richard Madeley[1], Dr Ian Clifton[1], Ms Charlotte Coles[2]

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P37 Home cardiorespiratory sleep studies - a viable alternative in paediatrics?

Mrs Elise Buchan[1], Mr Scott Tart[1], Mr Paul Burns[1], Dr Ross Langley[1], Dr Neil Gibson[1]

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Accepted abstracts

P = Poster, O = Oral

P38 A review of the frequency of follow up in Sheffield Teaching Hospital Interstitial Lung Disease (ILD) patients

Mr Iain Johnstone[1]

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P39 An audit of reproducibility standards for spirometry and gas transfer at Birmingham Heartlands Hospital

Mrs Yasmin Khan[1], Mrs Shannon Hodgkiss, Dr Vicky Moore, Mr Samuel Wallbanks

[1] UHB Heartlands Hospital, Bordesley Green East, United Kingdom

P40 APAP vs CPAP therapy: A retrospective analysis of clinical effectiveness and cost efficacy in the initial treatment of OSA

Miss Michelle Cole[1]

[1] University Hospitals Bristol And Weston NHS Trust, Bristol, United Kingdom

P41 Sleep disordered breathing in children with vagus nerve stimulation therapy

Mr Matthew Davies[1], Aidan Laverty[1], Dr Martin Samuels[1], Dr Vasileios Patelis[1]

[1] Great Ormond Street Hospital, London, United Kingdom

P42 Using quality improvement methodology to tackle ventilator preventative maintenance adherence

Miss Emily Young[1]

[1] University Hospitals of Leicester NHS Trust, Leicester, United Kingdom

P43 How well does pre-operative cardiopulmonary exercise testing predict hospital length of stay, 30-day, 90-day, 1-year and 2-year post-operative mortality?

Mr James Penrose[1], Mr Adrian Kendrick[1], Mr Mark Hardyman[1], Mrs Carla Thomson[1], Mr Liam Bagley[2]

[1] University Hospitals Bristol And Weston NHS Foundation Trust, Bristol, United Kingdom, [2] Manchester Metropolitan University, School of Healthcare Science, Manchester, United Kingdom

O1 Respiratory physicians collaborate with explainable artificial intelligence for improved diagnostic interpretation of pulmonary function tests

Marko Topalovic[1], Nilakash Das[1,3], Julie Maes[1], **Camille Vanhecke**[1], William D-C. Man[2], Wim Janssens[3]

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O2 Comparison of a flow volume analysis model against a human panel - A pilot study

Mark Unstead[1], Mrs Jessica Swan[1], Emily Seaman[1], Lise Sproson[2], Dr Ian Cliff[3]

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O3 Increased diagnostic information from multiple night oximetry in diagnosis of obstructive sleep apnoea

Mr Harry Kirby[1], Dr Emma-James Garden[1], Dr Anne McGown[1], Mr Mark Unstead[1]

[1] Royal Berkshire Hospital, Reading, United Kingdom

O4 CPET to identify breathing pattern disorders in children with exertional dyspnoea

Miss Natalie Jayne Orr[1], Charlotte Richardson[2], Hope Zied[3], Samantha Sonnappa[4]

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[2] Chief Respiratory Physiologist, Royal Brompton Hospital, London, United Kingdom

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POSTERS

POSTER 1

Increasing the flow of 100% Nitrogen to improve the accuracy of the Venturi Hypoxic Challenge Test

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Introduction: Hypoxic Challenge Tests (HCT) are used to assess the requirement for in flight supplemental O_2. In the UK a 40% O_2 venturi valve, driven by N2 rather than O_2 is the most commonly used technique to simulate the lower inspired O_2 pressure (Griffin & Purcell ARTP, 2018). However, the fraction of inspired O_2 (FiO_2) provided by this type of HCT may not always be the anticipated 15%. Indeed, the total flow of the venturi jet when driven by the recommended 10 l/min of N_2 is ~40 l/min which can be exceeded by tidal inspiratory flows. Room air is subsequently drawn through the expiratory ports (holes) to satisfy the deficit, increasing the FiO_2 above 15%. However, it has previously been shown that the total flow of the venturi jet can be increased by elevating the driving flow of O_2 above the recommended 10 l/min without effecting the FiO_2 (Vohra & Klocke, AARD 1993). We hypothesised this would also be true when N2 was used despite the difference in density from O_2.

Methods: The FiO_2 and the total flow of the venturi jet were measured using an Ultima CardiO_2/PFX analyser (MGC). The O_2 analyser was calibrated with room air and 12% O_2. The analyser was placed ~50 cm downstream of the venturi jet, centrally within 11 mm diameter tubing and recordings made after > 30 s of continuous flow to ensure complete gas mixing.

Results: Increasing the flow of N_2 from 10 to 15 l/min greatly increased the overall flow of the venturi jet without a meaningful change in the FiO_2 (Table 1). One of the three models of venturi valves tested produced an FiO_2 of 0.5% higher than the expected 15%.

Model of venturi valve	Total flow when driven with 10 l/min N_2	FiO_2 (%)	Total flow when driven with 15 l/min N_2	FiO_2 (%)	Difference in total flow	Difference in FiO_2 (%)
Flexicare 40% venturi LOT 1 91200097, REF 034-10-029C	49.2 l/min	15.5	73.2 l/min	15.6	24 l/min	0.10
Intersurgical LOT 32103328. REF 0040000	42.6 l/min	14.88	68.4 l/min	15.18	25.8 l/min	0.30
Lifecare. LOT M2011092. Ref L-4002/40%	44.4 l/min	14.97	64.8 l/min	15.08	20.4 l/min	0.11
Mean and SD	45.4 ± 2.78 l/min	15.12 ± 0.27	68.8 ± 3.44 l/min	15.29 ± 0.23	23.4 ± 2.24 l/min	0.17 ± 0.09

Table 1: FiO_2 and total flow from three different venturi valves when driven with 10 and 15 L/min N_2.

Conclusions: Increasing the flow of N_2 from 10 to 15 l/min through the venturi valve is likely to increase the accuracy of the venturi HCT. However, further studies are required to examine whether the higher flow of the venturi jet causes a pressure build up within the mask. Theoretically, this could alter the ratio of room air entrainment into the venturi jet effecting the FiO_2.

POSTER 2

Longitudinal comparison of hospitalised patients with and without COVID-19 related residual lung abnormalities

Miss Demi Jakymelen[1], Mr Ian Smith[2], Dr Laura Saunders[1], Dr Laurie Smith[1], Dr Roger Thompson[2], Professor Jim Wild[1]

[1] *University of Sheffield, Sheffield, United Kingdom,*

[2] *Sheffield Teaching Hospitals, Sheffield*

Introduction: Impaired lung function and residual lung abnormalities (RLA) on structural imaging have been observed in previously hospitalised COVID-19 patients (Stewart *et al.* AJRCCM 2022; in press). Longitudinal lung function changes in patients with and without COVID-19 related RLA remains unclear.

Methods: Patients hospitalised with COVID-19 pneumonia performed spirometry and gas transfer at 24 and 52 weeks post-admission and were assessed for RLA using CT or MRI at 12-weeks post-discharge.

Wilcoxon and Mann-Whitney tests assessed longitudinal and group comparisons respectively. Data are presented as median (IQR).

Results: 30 patients were assessed in total (M=25,F=5), age=63.6 (14.7) years, BMI=30.8 (4.1). 15 patients (9 with RLA) were assessed at both time-points. At 24 vs 52 weeks, 14 RLA and 7 non-RLA patients were tested vs 17 RLA and 7 non-RLA respectively.

At 24 weeks, 52.4% and 23.8% of all patients had an abnormal TLco and FVC respectively (Zscore<-1.64), all of whom had RLA. Of these, 80% and 18.2% had FVC and/or TLco increase to >-1.64 Z at 52 weeks.

At 24 weeks, patients with RLA had a lower FVC (Z=-1.47 vs 0.27, p=0.007), TLco (Z=-2.18 vs -0.47, p<0.001) and Va (Z=-2.73 vs -0.29, p<0.001) compared to those without. There were no significant differences for FEV_1, FEV_1/FVC or Kco at 24 weeks. At 52 weeks patients with RLA had significantly lower (p<0.02) TLco, Va and Kco (Z=-2.48 vs -0.31, -2.22 vs -0.49 and -1.17 vs, -0.03), than those without. There were no significant differences for FEV_1, FVC or FEV_1/FVC at 52 weeks.

No longitudinal changes were observed in non-RLA patients, however in RLA patients there was an increase in FVC (Z=-1.66 to -1.32, p=0.012) and a decrease in FEV_1/FVC (Z=0.61 to -0.09, p=0.004).

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Conclusions: Patients previously hospitalised with COVID-19 and resulting RLA on structural imaging, had significantly impaired gas transfer compared to those without, which persisted 1 year post-discharge, despite an improvement in lung compliance.

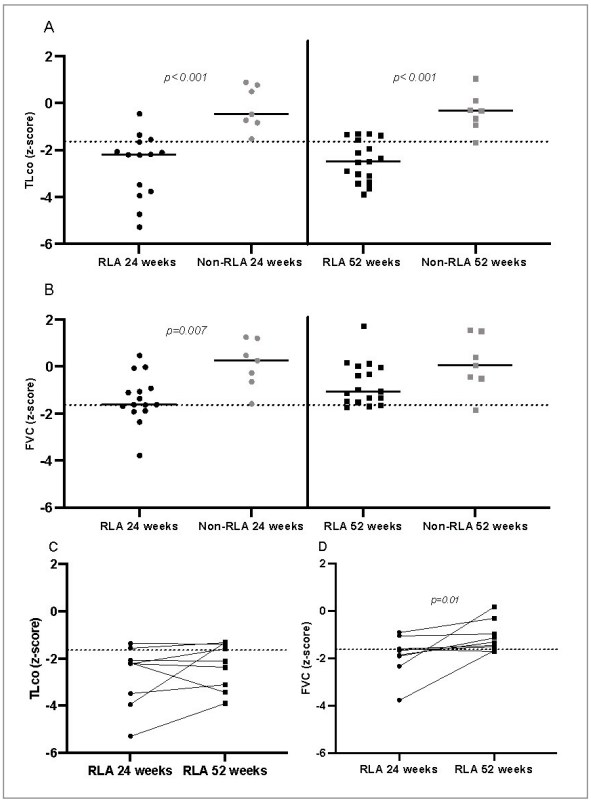

Figure 1. Between-group (A & B) and longitudinal (C & D) plots of TLco and FVC for patients with and without COVID-19 related RLA
Plots A and B show TLco (A) and FVC (B) Z-scores of patients with and without post-COVID-19 RLA at 24-and 52-weeks post-hospital admission. Patients with RLA had a reduced TLco at both 24- and 52-weeks compared to the non-RLA group and a reduced FVC at 24 weeks only. Plots C and D demonstrate the change in TLco (C) and FVC (D) Z-scores for those patients with post-COVID-19 RLA followed up at both 24- and 52-weeks post-hospital admission. At 52 weeks, compared to 24 weeks, patients with RLA had on average a significant increase in FVC, but did not have a significant increase in TLco. The dotted horizonal line on each plot indicates the lower limit of normal at a Z-score of -1.64. The solid horizontal lines on plots A and B indicate the group median for the surrounding data set.

POSTER 3

Longitudinal lung function trajectories in adults with severe asthma

Mr Samuel Wallbanks[1], Mr Max Thomas[1], Mr David McNulty[1], Professor Brendan Cooper[1], Professor Adel Mansur[1]

[1]*University Hospitals Birmingham, United Kingdom*

Introduction: There is a paucity of research on longitudinal lung function in severe asthma. This study retrospectively evaluates lung function trajectories in the Birmingham Regional Severe Asthma Service.

Methods: 140 severe asthmatics (107F, 33M) had spirometry values plotted longitudinally using SPIROLA. Differences between males and females were assessed using Mann-U-Whitney or t-tests (Chi squared or Fisher's exact test for frequencies and proportions). Statistical significance was accepted at an α-level of $p<0.05$. Reference values for lung function were based on Global Lung Initiative prediction equations. Slopes for longitudinal lung function were assessed using linear regression. Values are presented as median (IQR).

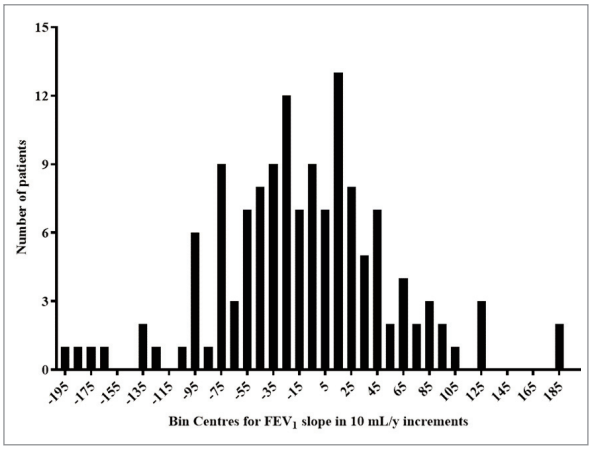

Figure 1. Distribution of FEV1 slopes in the cohort.

Results: Median follow-up duration was 92 months (83-118), with a median of 10 spirometry measurements per person (3-36). Sixty-one patients (43.6%) showed an increase in FEV_1 and 79 (56.4%) showed a decline in their regression slope. Median FEV_1 decline for males was -30 $mL{\cdot}y^{-1}$ (-55 to +24) and -0.22% $predicted{\cdot}y^{-1}$ (-0.99 to +1.16). Median decline for females was -6 $mL{\cdot}y^{-1}$ (-44.5 to +28.5) and -0.16% $predicted{\cdot}y^{-1}$ (-1.16 to +1.61). For FVC, median change for males was +10 $mL{\cdot}y^{-1}$ for males (-58 to +102) and -3 $mL{\cdot}y^{-1}$ for females (-42.5 to +41.5). Whilst no significant differences in FEV_1 or FVC slope were identified between males and females, a significantly higher proportion of males showed a ≥50 $mL{\cdot}y^{-1}$ decline in FEV_1 ($p=0.03$). During follow-up, females experienced significantly higher numbers of self-reported exacerbations versus males (2.4 (1.28-3.52) vs 1.89 (0.86-3.71) per year, $p=0.002$) and were on significantly higher doses of inhaled corticosteroids at baseline (2088 (1600-2000) vs 1600 (1000-2000) µg, $p = 0.037$).

Conclusions: Despite females having significantly higher numbers of exacerbations, levels of lung function decline were similar between males and females.

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POSTER 4

The effect of breathing pattern on airway resistance and reactance using forced oscillation technique (FOT)

Mr Mark Howlett-Foster[1], Miss Ella O'neill[1], Dr Karl Sylvester[1]

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Introduction: FOT measures the passive mechanical properties of the respiratory system during tidal breathing by measuring the forcing signal at the mouth. Changes between oscillatory pressure and flow are used to calculate the total mechanical properties of the respiratory system (Shirai and Kurosawa, INT MED 2016; 55: 559-556).

FOT is a useful assessment tool in asthma and it has been suggested that responses to bronchodilators and bronchoconstriction could be assessed using FOT (King *et al*., ERJ 2020; 55: 1900753). However, approximately 30% of patients with asthma may also have a breathing pattern disorder (Tay *et al*., RESP 2016; 21: 1384-1390). It is unclear whether an abnormal breathing pattern affects FOT measurements that may impact accuracy of reversibility and challenge assessments.

This study aims to examine the effect of breathing frequency (BF) on measures of airway resistance and reactance obtained from FOT.

Method: Following a within-subject randomized study design participants (n=7; male: 5; age: 31±8yr; height: 1.77±0.1m; weight: 78±14kg; with normal spirometry: FEV_1 SR: –0.2±0.68) performed FOT (Resmon Pro, Restech Srl). Four BF were chosen (15, 20, 30, 40 breaths per minute), with measurements at each BF performed in triplicate. Data analyses were performed to assess differences between BF for measures of total airway resistance (R5, R11 & R19) and total airway reactance (X5, X11 & X19).

Results: No significant differences were found between BF for all measures. Although on average there was a trend for higher BF to result in marginal reduction in airway resistance (table 1).

	BF15	BF40	% Difference
R5tot	2.79 ± 0.68	2.6 ± 0.52	-7%
R11tot	2.69 ± 0.7	2.45 ± 0.48	-10%
R19tot	2.87 ± 0.62	2.70 ±0.47	-6%

Table 1: Mean airway resistance BF15 vs BF40 and % difference. Mean ± SD.

Conclusion: BF does not significantly impact measures of airway resistance and reactance using FOT. Although higher BF may slightly influence results, this study suggests this is not at the level of the expected positive response to either a bronchodilator or bronchoconstriction agent via FOT (King *et al*., ERJ 2020; 55: 1900753). Further investigations into the effect BF may have on the results obtained using FOT should include measurements taken from a clinical population, to determine if there are greater implications of changes in BF of patients with obstructive lung disease.

Does this study use human subjects, human biopsy or genetic material? Yes / ~~No~~

1. Please note participants were employees of the department and not patients receiving care within the service.

POSTER 5

Predictors of response to anti-IL-5 biologics in the Birmingham Regional Severe Asthma Service (BRSAS)

Mr Samuel Wallbanks[1], Mr Maximillian Thomas[1], Professor Brendan Cooper[1], Mr David McNulty[1], Professor Adel Mansur[1]

[1] *University Hospitals Birmingham, United Kingdom*

Introduction: Sources of variation in response to anti-IL-5 therapies in severe asthma are not fully understood. This study retrospectively evaluates the effects and predictors of response to anti-IL-5 biologics in the Birmingham Regional Severe Asthma Service.

Methods: Patients were classified into no response, positive response and super-responders to therapy based on the outcomes of a recent Delphi process (1). The minimum criteria to define a positive response was a 75% reduction in exacerbations from baseline across the 12-month follow-up period. Super-responders were classified based on complete cessation of exacerbations and oral corticosteroids. Predictors of response to therapy were assessed using logistical regression analysis, with presentation of Odds Ratios and 95% confidence intervals for each variable. Following normality testing, tests of difference were also performed to measure differences in baseline characteristics in responders and non-responders. Statistical significance was accepted at an α-level of $p < 0.05$.

Results: Of 146 severe asthmatics, 128 (87.7%), 17 (11.6%) and 1 (0.7%) were taking Mepolizumab, Benralizumab and Reslizumab, respectively. Fifty-eight severe asthmatics had no response (39.7%), 52 showed a positive response (35.6%) and 36 were super-responders (24.7%) to anti-IL-5 therapies.

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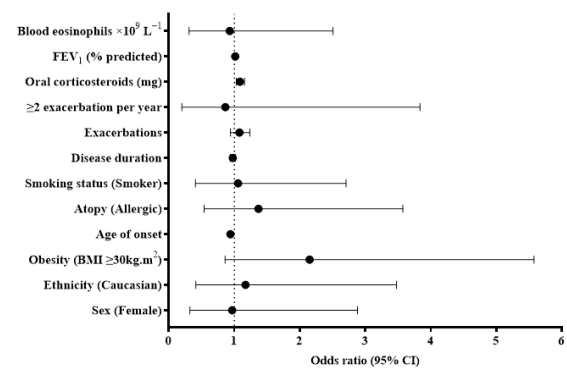


Figure 1. Predictors of response to anti-IL-5 biologics.

Compared with non-responders, responders to anti-IL-5 therapy had significantly older age of onset (30.0 (11.3-46.8) vs 10.5 (0.75-22.0) years, p<0.001) and shorter disease duration (19.2 (5.1-30.1) vs 29.3 (15.5-39.4) years, p=0.007). Responders also had significantly higher peak levels of blood eosinophils at baseline compared to non-responders (0.84 (0.51-1.23) vs 0.6 (0.41-0.91) ×109 L^{-1}, p=0.012).

Conclusions: Raised blood eosinophils, adult-onset disease and shorter disease duration may contribute to preferential response to anti-IL-5 biologics.

References

1. Rupani & Hew, JACI, 2021.

POSTER 6

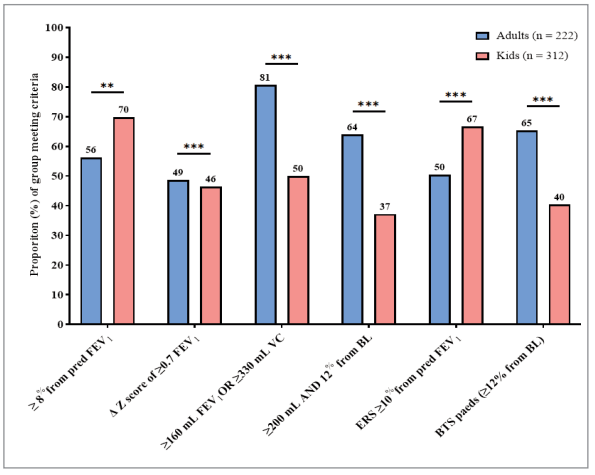
How sensitive are reversibility criteria in paediatric and adult asthma?

Mr Samuel Wallbanks[1], Mr Paul Burns[2], Mr Max Thomas[1]

[1]Birmingham Heartlands Hospital, Birmingham, United Kingdom, [2] NHS Greater Glasgow and Clyde, Glasgow, United Kingdom

Introduction: The level of change in lung function to define a clinically meaningful reversibility test is the source of much debate. Evidence underpinning previous guidance has lacked application to children and the full array of airway disease (1). This study aims to improve understanding of the sensitivity of reversibility thresholds in child and adult patients with severe asthma.

Methods: Data from reversibility assessments (2.5 mg nebulised salbutamol) were retrospectively analysed from severe asthmatics being treated at the Royal Hospital for Children and Birmingham Severe Asthma Services. The sensitivity of 6 commonly used reversibility criteria were assessed by measuring the proportion of patients meeting each criterion. Changes in FEV_1 (mL, % change from baseline, % from predicted and z score) after bronchodilation were presented as median and inter-quartile range. Differences between children and adults were assessed with Chi-squared or Fisher's exact test. Statistical significance was accepted at a α-level of p<0.05. Reference values for FEV_1 were calculated using current Global Lung Initiative reference equations.



Results: In adults with severe asthma, median improvement in FEV_1 was 290 mL (160-497), 15.9% from baseline (7.8-30.7), 10.0 % from predicted (5.3-15.9) and 0.7 in Z score (0.4-1.1). In children, median improvement in FEV_1 was 150 mL (40-340), 8.7 % (2.1-19.2), 17.5% from predicted (4.5-38.5) and 0.6 in Z score (0.2-1.3). Within the whole cohort, 86.4% (223 of 258) of patients with a positive reversibility (200 mL and 12%) had obstructive spirometry at baseline.

Conclusions: 8% and 10% change from predicted criteria are most sensitive to asthma in children. In adults, a lower threshold of ≥160 mL change in FEV_1 offers much higher sensitivity; however, the implications for ruling out asthma diagnoses (i.e. specificity) are unclear.

References

1. Stanojevic et al, 2022, ERS technical standard on interpretation of lung function tests, ERJ.

POSTER 7

The Inspired Sinewave Test (IST): A New Method to Assess Lung Volume and Ventilatory Heterogeneity

Ms Suzanne Taylor[1], Dr Minh Tran[2], Dr Caroline Jolley[1], Prof. Mona Bafadhel[1], Prof. Andrew Farmery[2], Dr Phi Phan[2], Dr Richard Bruce[1]

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Introduction: The Inspired Sinewave Test (IST) is a novel and simple-to-perform method to assess cardiorespiratory. It allows the measurement of lung volume (functional residual capacity, FRC), pulmonary blood flow, and indices of ventilation heterogeneity (VH). In the initial stages of its

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development we aim to assess the agreement between its measurement of lung volume with multi-breath nitrogen washout (MBNW) and whole body plethysmography (pleth). We also aim to assess the relationship between IST indices of VH with that of MBNW lung clearance index (LCI). Finally, as ageing is known to impact FRC and VH, we aim to assess IST performance in those of different ages.

Methods: Forty healthy never-smoker volunteers free of respiratory disease were assigned to an age-dependent group: 20-40 yrs (n=20) or 60-80 yrs (n=20). During one testing session, each participant completed spirometry, gas transfer, whole body plethysmography and the MBNW test. The IST test was then completed 4 times, each constituting 4 min tidal breathing whilst inhaling varying [N_2O], oscillated in sinewave patterns over a set period of 180 or 90 s. Infrared gas sensors monitor N_2O in expired gas, and mathematical lung models use the inspiratory and expiratory N2O sinewaves to estimate cardiorespiratory parameters.

Results: In the young group, Bland-Altman analysis revealed that the agreement in FRC was closer between FRC_{IST} vs. FRC_{MBNW} (Mean Bias: -0.31L, Limits of agreement: ±0.9) in comparison to FRC_{IST} vs. FRC_{pleth} (-0.72L±1.2). This agreement became wider in older participants (FRC_{IST} vs. FRC_{pleth} = -1.4L±1.9). Both LCI and IST measures were similarly able to detect increases in VH with age.

Conclusions: The agreement in FRC between the IST and other established methods (MBNW, whole body plethysmography) become poorer in older participants. This is likely because the IST method is more sensitive to increasing VH with age, which therefore offers a novel method to quantify VH.

POSTER 8

Implementation of a new asthma diagnostic pathway in an acute hospital trust

Mrs Carla Thomson[1], Mr Mark Hardyman[1], Miss Tasmin Sharley[1]

[1] University Hospitals Bristol and Weston NHS Foundation Trust, Bristol, United Kingdom

Introduction Asthma is a condition which affects approximately 12% of the UK population. It is defined as a chronic inflammatory condition of the airways. The airways are hyper-responsive to a range of stimuli, resulting in airway narrowing which can cause cough, wheeze, chest tightness and shortness of breath. Currently there is no single diagnostic test for asthma however tests that can help support an asthma diagnosis include; fractional exhaled nitric oxide (FeNO), spirometry, bronchodilator reversibility (BDR), peak expiratory flow readings and bronchial challenge testing. It was noted that different approaches were being taken by referrers to determine if a patient could be given a diagnosis of asthma. As a result an asthma diagnostic pathway (ADP) was designed to ensure patients were diagnosed efficiently on a standardised care plan. The aim was to evaluate the implementation of an ADP within a Respiratory Department at an acute hospital trust.

Method Patients were referred to the lung function service by requesting an ADP appointment. At the first appointment the patient underwent FeNO and BDR (2.5 mg Salbutamol via a nebuliser). A senior Respiratory Physiologist reviewed the results and if the patient had a FeNO ≥40 ppb and/or an increase in FEV_1 ≥12% and ≥200 ml this was classed as a positive test and the patient was booked into a Consultant appointment. If they did not meet these criteria, a Mannitol Challenge Test (MCT) was requested. After the MCT they were booked into a Consultant appointment to discuss the results (Figure 1).

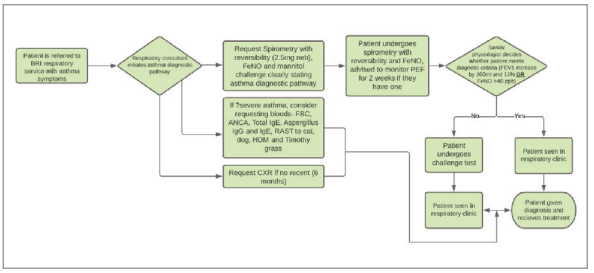

Figure 1 Flow diagram of the asthma diagnostic pathway

Results Since August 2021; 227 patients entered the ADP, 82 of which completed the pathway (49 female and 33 male; mean age 49.3 years). 28 tested positive at Stage 1 and 7 tested positive at Stage 2.

Conclusion 54 consultant appointments have been saved. There are 19 patients who should have been referred for Mannitol but have not had an appointment booked, therefore the robustness of the pathway needs to be investigated.

POSTER 9

Analysis of the ATS/ERS 2019 FIVC criterion in COPD patients.

Mr Anthony Dean[1], James Dean[1,2], Dave Singh[1,2]

[1] The Medicines Evaluation Unit, United Kingdom,

[2] The University of Manchester, United Kingdom

Background The current ATS/ERS guidelines (Graham *et al*. Am J Respir Crit Care Med 2019; 200: 963- 971) state that a spirometry manoeuvre is unacceptable if the forced inspiratory vital capacity (FIVC) is >105% of the forced vital capacity (FVC), signifying submaximal inhalation prior to the FVC. In COPD patients, this criterion may be more

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difficult to achieve, as this group tend to have impaired respiratory mechanics and muscle function (De Troyer. Eur Respir J 1997; 10: 708-713). This study assesses the incidence of failed spirometry manoeuvres in relation to severity of COPD.

Methods Retrospective data from 30 mild (FEV_1>80%) and 26 severe (FEV_1<50%) COPD patients was analysed. Manoeuvres where FIVC was less than 90% of FVC were excluded from analysis (n=100), as FIVC was assumed to be incomplete. This resulted in 53 and 42 manoeuvres available for analysis in the mild and severe groups, respectively. Manoeuvres where FIVC was between 90% and 105% of FVC were considered 'acceptable', and those above 105% were considered to have failed the FIVC criterion ('failed'). Ethics committee approval was obtained for all data collection. Fisher's exact test with Baptista-Pike test was performed using Prism, and a p value of <0.05 was considered significant.

Results The incidence of failed tests are shown in figure 1. In the severe group, 12 manoeuvres (29%) were labelled 'failed', compared to 1 manoeuvre (2%) in the mild group (p=0.0002). The odds ratio showed failed manoeuvres were 20.8 times more likely in severe patients compared to mild patients (95% CI: 3.3 – 226.6).

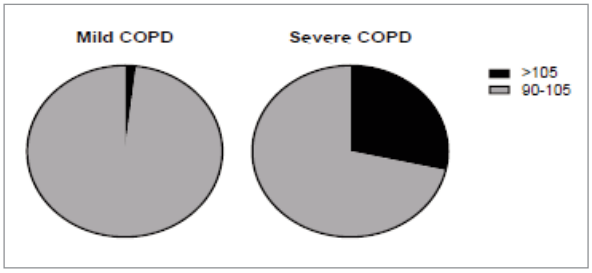

Figure 1. Incidence of failed FIVC criterion in Mild and Severe COPD patients. Failed manoeuvres were classified with a FIVC >105% of FVC (black), and acceptable manoeuvres were classified with a FIVC between 90-105% of FVC (grey).

Conclusion It is more common for severe COPD patients to fail the ATS/ERS FIVC criterion, compared to mild COPD patients. While we did not investigate the mechanisms involved, the role of impaired respiratory mechanics, muscle weakness and poor technique should be considered.

POSTER 10

Is heart rate recovery an accurate predictor of postoperative mortality?

Mr Joshua Hayter[1], Miss Jade Aston[1]

[1] *Bristol Royal Infirmary, Bristol, United Kingdom*

Introduction Cardio-pulmonary exercise tests (CPET) are widely used to predict surgical outcomes for major surgery. In current practice, absolute V̇O2 peak, peak V̇O2/kg, anaerobic threshold (AT) and O2 pulse are used to determine these risks. However, little is done to analysis post CPET recovery data in order to determine a patients risk for surgery. The time it takes for a person's heart rate (HR) to recovery have been used as a measure of their overall cardiovascular health. Therefore, analysing the speed of the patient heart rate recovery (HRR) theoretically could be used to help determine post-surgery mortality risk.

Method 94 subjects were identified from retrospective data between 01/01/2019-31/12/2020, with subjects required to have completed a CPET on a treadmill ergometer, achieved >90% of their predicted HR maximum and had surgery performed within 6 months of testing. HRR was calculated using the slopes of the HR decline over a minute from the initial fall seen shortly after exercise termination. Receiver operator characteristic (ROC) curve were produced for 90, 180 and 365-days post-surgery. The area under the curve (AUC) were analysed and cut off values were used to identify the level of discrimination

Results Primary analysis found that ROC curves produced for 90, 180 and 365-days post-surgery showed no level of discrimination (AUC <0.5), wide confidence intervals and results were insignificant (P>0.05). Other commonly used indices to predict surgical outcomes such as peak VO2/kg, VO2@AT, O2 Pulse and minute ventilation/carbon dioxide production (VE/VCO2 slope) slope found similar results (Figure 1). These were all found to be insignificant and no level of discrimination apart from VE/VCO2 slope which was classified as poo (0.5 – 0.7).

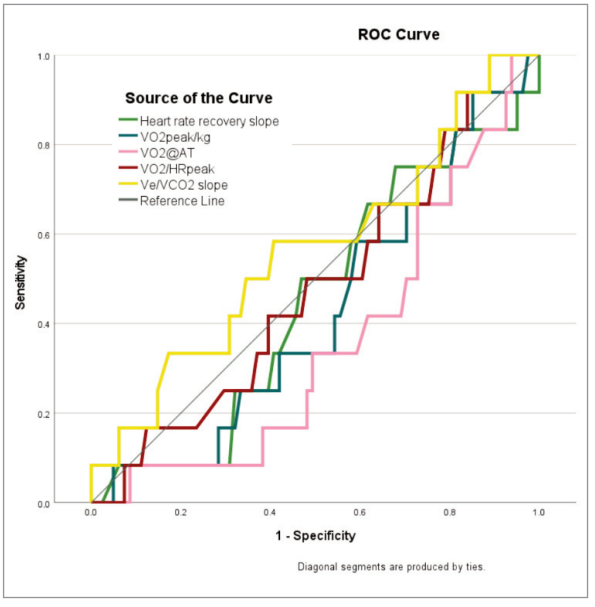

Figure 1. ROC curve showing 365-day postoperative mortality for multiple CPET indices.

Conclusion This study suggests that HRR poorly predict 90, 180 and 365 day mortality. Further research should investigation a larger sample size in order to identify more robust postoperative predictors.

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POSTER 11
Assessing the impact of COVID-19 on patient breathlessness and sleep quality in community settings.

Mr Henry Hodgkins[1], Dr Mark Faghy[2], Dr Tom Madden-Wilkinson[3], Miss Rebecca Owen[2], Dr Ash Willmott[1]

[1] Anglia Ruskin University, Cambridge, United Kingdom, [2] University of Derby, Derby, United Kingdom, [3] Sheffield Hallam University, Sheffield, United Kingdom

Introduction: At least 10% of those infected with Coronavirus-2019 (COVID-19) suffer from long-COVID, where symptoms can persist for >12-weeks. This study aimed to investigate the long-term effects of COVID-19 on breathlessness and sleep quality which were under researched in the long-COVID literature.

Method: An online survey (Qualtrics) was designed and contained 70 questions, across 7 sections, including: participant characteristics, COVID-19 symptoms, sleep quality, breathlessness, physical activity, and mental wellbeing.

Statistical analyses were performed using SPSS using mixed-ANOVA and Kruskal-Wallis H for comparisons between >2 groups (breathlessness, physical activity), Pearson's correlation coefficient for relationships between groups (sleep duration and quality), and Mann-Whitney U for difference between two groups (pre- and post-COVID general health).

Results: Three hundred and eighty-one participants completed the survey (83% female; age, 42 ± 12 years; body mass index, 29.1 ± 8.4 kg.m2). Eighty-eight percent (n = 337) of participants experienced one or more COVID-19 symptoms, and reported general health significantly reduced from 'good to excellent', to 'fair to poor' following COVID-19 infection ($p < 0.001$). Fifty-eight percent (n = 221) reported being unable to complete activities of daily living due to breathlessness. Significant correlations were found between the number, severity, and duration of initial symptoms, and breathlessness severity (Table 1). Eighty-three percent (n = 318) reported a decline in sleep quality. Moderate correlations were found between sleep quality and the number of initial symptoms (r = 0.35), and general health (r = 0.42).

Conclusion: COVID-19 induced negative long-term effects on sleep and breathlessness which have a direct effect of quality of life, and ability to carry out activities of daily living. More research is required to understand the underlying mechanisms, and for prescription of rehabilitation techniques.

This study used human participants

	1	2	3	4
(1) Breathlessness severity				
(2) Number of initial symptoms	.457**			
(3) Severity of initial symptoms	.131*	.110*		
(4) Duration of symptoms	.268**	.281**	.190**	
Post-COVID general health	.556**	.429**	.156**	.513**

Table 1: Pearson's coefficient correlations showing the associations between post-COVID-19 breathlessness and 4 predictor variables (df = 358).
Correlations bootstrapped (x1000) unless otherwise stated.
* Correlation is significant at the 0.025 level (2-tailed)
** Correlation is significant at the 0.01 level (2-tailed)

Ethical approval was gained from both Anglia Ruskin University (SREP code: SES20-10).

POSTER 12
Home spirometry to titrate and monitor treatment in a patient with sarcoidosis

Miss Catherine Dixon[1], Emma Buckroyd[1], Dr Huzaifa Adamali[1]

[1] North Bristol NHS Trust, Bristol, United Kingdom

Introduction Home spirometry has been shown to be a feasible and valid measure of lung function in patients with lung disease and has received heighted interest due to the Covid-19 pandemic. At North Bristol NHS Trust a small cohort of patients with interstitial lung disease are monitored using home spirometry for disease monitoring, including steroid weaning.

Case Presentation A 30-year man with sarcoidosis, started home spirometry in May 2022 to monitor the effect of steroid weaning on his lung function. He considered the side effects of corticosteroids to be unacceptable and a fine balance was necessary to allow medication titration without disease deterioration.

He was asked to perform spirometry twice weekly to enable early identification of deterioration. Spirometry was performed independently with good technique. Compliance with home spirometry was good and results were received via email at least once a week. Results were reviewed and compared to previous, to assess for deterioration which may require alteration to his steroid weaning.

In August he contracted Covid-19 and stopped performing spirometry for one month. On resuming home spirometry, a drop of 10% and 6% in FEV_1 and FVC respectively was observed. Results were reviewed to eliminate poor technique as a reason for the decline and then highlighted to his consultant. This triggered a clinic review and chest x-ray, and his prednisolone was increased to 10mg, and azathioprine introduced. Regular home spirometry was resumed, and his results gradually improved to pre Covid-19 infection values.

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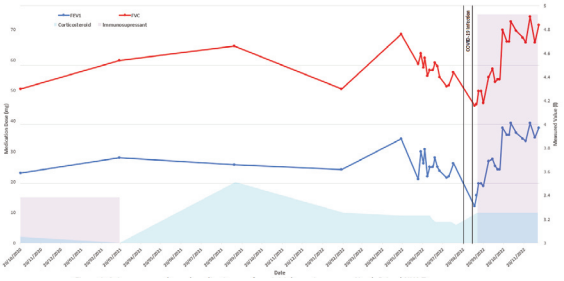
Discussion This case study highlights the usefulness of home spirometry in the early identification of deterioration in lung function and consequently early treatment intervention in a patient with sarcoidosis. In this case the decline was due to Covid-19 infection, but the same principles could be applied to other reasons for deterioration to enable prompt intervention and prevent further declines in lung function.



Immunosupressant: Initially methotrexate (15mg) stopped due to resolution of sarcodosis on imaging. Azathioprine (75mg) introduced following deterioriation as a secondline treatment.
Corticosteroid: Oral prednisolone
COVID-19 infection: Tested positive 21/08/2022 - 05/09/2022

Figure 1 Spirometry results and medication use from initial appointment at North Bristol NHS Trust

POSTER 13

Lung function improvement in a patient with cystic fibrosis and advanced lung disease after commencement of Elexacaftor- Tezacaftor-Ivacaftor

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Background: Cystic fibrosis (CF) results from mutations in the cystic fibrosis transmembrane regulator (CFTR) genes. CFTR modulators treat CF at the molecular level, transforming care traditionally focussed on aggressive symptom management [1]. Elexacaftor-Tezacaftor-Ivacaftor (ETI) proved effective in patients heterozygous for Phe508del and a minimal function mutation, with a percentage of predicted forced expiratory volume in 1 second ($ppFEV_1$) of 40%-90% at screening for a phase 3 trial ETI [2].

Case Presentation: 31-year-old, heterozygous for Phe508del and minimal function mutation. Worsening lung disease had resulted in 6 admissions in 6 months, treated with intravenous (IV) antibiotics due to pulmonary exacerbations (PEx). Referral for lung transplant (LTx) assessment deemed an increased risk due to chronic kidney disease and poor diabetic control, advising extra input from Nephrology.

ETI was initiated via a compassionate use program when $ppFEV_1$ was 34%. The absolute change in $ppFEV_1$ (Δ $ppFEV_1$) increased 50% at 3 weeks (Table 1) and was sustained through week 87 (Δ $ppFEV_1$ 48%), with 1 PEx requiring IV antibiotics (week 84).

The patient currently exceeds clinical severity criteria required for LTx consideration.

Week	FEV1 (L)	ppFEV1 (%)	Absolute Δ ppFEV1 (%)	FVC (L)	ppFVC (%)	Absolute Δ ppFVC (%)	FEV1/FVC	FEF25-75 (L/s)	FEF25-75 (%)	PEF (L/min
0	1.35	34	0	2.07	44	0	65.2	0.84	20	306
1	2.74	70	36	3.83	81	37	71.6	1.85	44	550
3	3.3	84	50	4.31	92	48	76.6	2.74	66	599
8	3.08	78	44	4.38	93	49	70.3	2.03	49	334
41	2.87	73	39	3.9	83	39	73.4	2.12	51	548
81	2.96	76	42	4.16	89	45	71.3	2.1	51	558
84	2.6	67	33	3.56	76	32	73.1	1.87	46	527
87	3.2	82	48	4.55	97	53	70.4	2.24	55	536

Table 1: Main spirometry results following initiation of ETI over the treatment period.

Conclusions: This case shows ETI can increase lung function considerably when baseline $ppFEV_1$ <40%, a subgroup underrepresented (8.4%) in phase 3 trials [2]. The Δ $ppFEV_1$ can remain elevated for 87 weeks, and decrease PEx frequency, reducing IV antibiotics requirement from 6 in 24 weeks to 1 in 87 weeks.

To our knowledge, data specific to this subgroup ($ppFEV_1$ <40%) remains unreported in the UK CF cohort and absolute Δ $ppFEV_1$ has not been reported at >24 weeks. This case supports a study that reported 73% of patients were taken off LTx wait list after starting ETI [3]. Larger cohort studies are required to assess the long-term impacts on morbidity and mortality, and the impact reduced PEx burden and reduced need for LTx could have on service provision.

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1. Lopes-Pacheco M. CFTR Modulators: The Changing Face of Cystic Fibrosis in the Era of Precision Medicine. Front. Pharmocol. 2020; 10: 1662.
2. Middleton PG, Mall MA, Drevinek P, et al. Elexacaftor-tezacaftor-ivacaftor for cystic fibrosis with a single Phe508del allele. N Eng J Med 2019; 381: 1809-1819.
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POSTER 14

Quality and adherence of home spirometry in a remote respiratory physiologist-led assessment

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Introduction Remote home spirometry can inform and confirm respiratory diagnosis, capture symptomatic data and address the capacity and demand mismatch within

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secondary care. However, limited data exists regarding the quality of and adherence to home spirometry in an adult asthma population. Previous research has found wide variation in adherence to 1 or 2 home spirometry sessions a week from 19-91% (Lechtzin *et al*. AJRCCM 2017; 196(9): 1144-51; Althobiani *et al*. ERJ 2022; 60(66): 1756). This study investigated the adherence to a 4 times per week home spirometry regime and measured the quality of spirometric data in a physiologist-led home assessment service.

Methods A group of 35 patients (6 male, 29 female) mean(±SD) age 47.5(±14.7) years, height 164(±8.7)cm were referred from Arrowe Park's severe asthma service to NuvoAir's asthma assessment service. Patients had a 12 week home lung function assessment period, performing spirometry 4 times per week and anytime they were symptomatic using the NuvoAir AirNext Bluetooth enabled spirometer and mobile app. Patients were onboarded to the service over video and phone calls with physiologists and were coached to perform independent quality assured spirometry.

Results Spirometry data was taken from a total of 1554 sessions performed by the patients during the assessment period. The median (IQR) engagement was 97% (68-116%). Spirometry data quality was graded A-F using ATS/ERS 2005 guidelines; 77% of spirometry tests achieved acceptable grade A-C spirometry (Fig.), 23% were graded from D-F.

Conclusions For this population of adults, grade A-C spirometry 4 times a week for 12 weeks was feasible. Unlike other home spirometry studies, this cohort received remote physiologist support which enhanced both engagement and data quality. High quality longitudinal data has the potential to provide a more detailed assessment of asthma control resulting in more informed or accelerated clinical decision making.

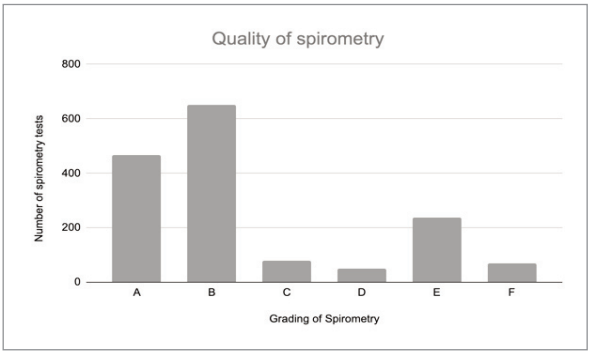

Figure: Bar chart showing ATS/ERS 2005 quality grading of 1554 recorded spirometry sessions.

POSTER 15

Case study: Pectus Excavatum: Is surgery more than just cosmetic?

Mrs Devra Hepple[1], Mr Christopher Satur[1], Dr Ian Cliff[1]

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Introduction Pectus Excavatum (PE) is a depression of the sternum and anterior chest wall that affects 1:300-400 births with a male predominance. Symptoms include shortness of breath (SOB), decreased stamina and chest pain with associated reduced self-esteem.

We present a case that demonstrates that surgical correction, offers relief of exercise dysfunction. However, surgical treatment is currently not endorsed by NHS England.

Case study A 19-year-old male had developed sternal depression consistent with the diagnosis of PE in early adolescence. Psychological symptoms included difficulty in forming personal relationships and compromised exercise tolerance, which coincided with increasing severity of PE during his growth spurt. He was able to climb two flights of stairs but needed to stop after this due to overt SOB. Moreover, he described fatigue towards the end of the day, but did not attribute this to the PE. Examination demonstrated an obvious symmetrical pectus defect, and a CT scan confirmed a severe PE causing depression of the whole sternum.

It was apparent he was keen to pursue corrective surgery, and therefore underwent pre-operative protocolised physiological assessment; a Cardiopulmonary Exercise Test (CPET) and respiratory function tests.

Results The results showed compromised exercise function associated with reduced oxygen consumption, reduced stroke volume and compromised ventilation (Table 1). After surgical correction he reported marked improvement in symptoms and improved physiological responses to exercise.

Parameter	Pre –surgical (%PD)	Post-surgical (% PD)	% Change
Peak VO2	28.8 (66%)	34.3 (80%)	16%
AT	16.6 (37%)	18.2 (42%)	9%
VE	56 (34%)	92 (33%)	40%
O2 pulse	13 (75%)	16 (89%)	19%
VO2/work slope	9.2	12.6	27%

Table 1: CPET result pre and post PE correction

Outcome The results confirm that symptoms of exercise dysfunction arise secondary to the development of PE in adolescence caused by compromised exercise physiology. The results also demonstrate that surgical treatment both

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improved the patient's symptoms and corrected the physiological anomalies and provides evidence that supports the need for surgical treatment for patients with PE.

POSTER 16
Role of home spirometry post the COVID-19 pandemic

Miss Charlotte Richardson[1], Miss Natalie Orr[1], Mrs Sarah Ollosson[1]

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Introduction: A home spirometry service was rolled out to over 400 paediatric patients at the start of the COVID-19 pandemic as part of a rapid shift to home monitoring (Richardson et al, Paediatr Respir Rev. 2022 Jun;42:43-48). The physiology led service has continued despite face to face services resuming, therefore what is the role of home spirometry going forward and is the service still being utilised by patients.

Methods: For an 8-week period the following data was audited for all patients with a home spirometer seen in an outpatient clinic: spirometry done prior to face to face appointment and by cohort, corrections made prior to uploading and number of repeated tests. For a 12-week period also audited usage of home spirometer outside of clinic appointments across different cohorts.

Results: Out of 144 patients who were sent reminders (via text) 77 (53%) performed spirometry prior to their clinic appointment over an 8-week period. Over a 12-week period how many patients performed at least one test session, 191 (61%) Cystic Fibrosis (CF), Primary Ciliary Dyskinesia (PCD) and Chronic Suppurative Lung Disease (CSLD) patients and 42 (58%) asthma patients.

		Yes	No
Spirometry done prior to face to face appointment. n=144	*CF* *PCD* *Asthma* *CSLD*	50% 41% 37.5% 50%	50% 59% 62.5% 50%
Corrections made prior to uploading to patient's electronic record	*CF* *PCD* *Asthma* *CSLD*	13% 69% 25% 0%	87% 31% 75% 100%
Spirometry repeated at clinic visit	*CF* *PCD* *Asthma* *CSLD*	19% 53.4% 33.3% 50%	81% 46.6% 66.6% 50%
Spirometry done prior to clinic with no corrections or repeated	*CF* *PCD* *Asthma* *CSLD*	36.5% 12.5% 10% 50%	63.5% 87.5% 90% 50%

Table 1: Percent predicted breakdown of spirometry done prior to clinic, corrections needed and if spirometry needed to be repeated by patient cohort.

Conclusions: Going forward home spirometry has a role as part of the clinical monitoring of paediatric patients. It must be acknowledged that the service has mixed success. On one hand for certain patients, home spirometry offers an innovative and time-saving alternative to clinic spirometry, which can empower patients to take ownership of their care. On the other hand, it is time consuming for staff, with corrections needed to be made to reports due to incorrect demographics and/or technique and repeat spirometry testing required for some when seen at clinic appointments. A targeted approach is needed as the service works well for some patients and patient cohorts but not all.

POSTER 17
Are all upper airway symptoms due to inducible laryngeal obstruction?

Miss Catherine Dixon[1], **Emma Buckroyd**[1]

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Introduction Excessive dynamic upper airway collapse can cause noisy breathing and dyspnoea. It has multiple aetiologies which result in an inward force of the tracheobronchial or cartilaginous membrane. Diagnosis is challenging with many tests, including spirometry, being normal. Upper airway collapse is often misdiagnosed thus left untreated. Dynamic CT scans and dynamic visualisation can be used to aid its diagnosis.

Case Presentation A 68-year-old male elite cyclist presented with increasing exertional dyspnoea following surgery. His symptoms included tightness and wheezing in his upper chest and throat, causing him distress.

Results from lung function tests, echocardiogram, ECG and cardiopulmonary exercise test were normal (Table 1). During the exercise test upper airway symptoms occurred and noises were heard, and a diagnosis of inducible laryngeal obstruction was considered. He attended the multidisciplinary upper airway assessment clinic and underwent continuous laryngoscopy during exercise. Symptoms occurred with increasing work rate with no evidence of inducible laryngeal obstruction. Excessive dynamic upper airway collapse was however observed beyond the larynx on expiration.

He underwent speech and language therapy, learning techniques to splint open his airways. Since this intervention, there were no further episodes of airway difficulty; he continues to use the techniques when cycling to good effect.

Discussion This case illustrates that, despite normal preliminary results, upper airway diagnoses should be considered, especially when symptoms are persistent and burdensome. It highlights the usefulness of continuous

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laryngoscopy in the assessment of upper airway symptoms and identification of dynamic upper airway collapse. It shows that not all upper airway noise is due to inducible laryngeal obstruction and other diagnoses should be considered. The multidisciplinary approach to this case resulted in the correct diagnosis and effective treatment.

Parameter	Predicted	Measured
FEV1 (l)	2.83	2.92
FVC (l)	3.68	3.79
FEV1/FVC (%)	76.87	77.02
PEF (l/min)	446	499
TLco	7.63	6.94
Kco	1.40	1.30
VA (l)	5.45	5.36
VO2 peak ml/min	1801	2578
VO2 at AT (%)		76
Peak VE (l/min)	102	112
Peak HR (bpm)	151	160

Table 1: Results from lung function tests and Cardiopulmonary Exercise Test

POSTER 18

Evaluation of pulmonary function test frequency in Interstitial Lung Disease (ILD)

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Introduction: There is inter observer variability in requesting of pulmonary function (PFT) in ILD. This study explores the pattern of referral and testing using Z-Score to classify severity, which guides management and treatment.

Method: Diagnosed ILD patients were classified as per National institute for Clinical Excellence (NICE) Z-score limits (n-120) as mild, moderate, and severe, respectively. Consultant referral patterns and testing intervals (both by severity and sub-class of ILD (UIP, Sarcoidosis, CTD, Chemical Exposure, NSIP, Other IP) were assessed for statistical significance. All required local hospital ethics approvals were completed, respectively.

Results: There was no significant difference between the median interval for consultant referrals (40.8±31.2 weeks) and pulmonary function tests (45.5±28.2 weeks) interval in weeks. (1.48 and 1.52 mean rank respectively, Chi-squared: 0.133, p= 0.715). There was no significant difference between median lung function testing intervals when severity (mild 4527.2; moderate 4621.4; severe 4235.4) was considered (p= 0.90). However, there was a significant difference (p= 0.033; mild vs moderate p=0.05; mild vs severe p=0.21) between consultant requests for mild patients compared to moderate and severe. When median interval for pulmonary function testing was compared by ILD sub-class (UIP 43.125.2; Sarcoidosis 47.722.6; Other ILs 44.932.3; CTD 60.744.7; Chemical Exposure 3417.6; NSIP 40.515.9) there was no significant difference (p=0.34).

Conclusion: Overall, intervals between referrals and lung function tests were similar in the ILD cohort. Severity was not a determining factor for the frequency of lung function testing. Although, referrals from consultants for mild patients were less frequent as compared with moderate and severe patients. Although median lung function testing intervals were varied when sub-classes of ILD were compared, there was not a significant difference across the groups.

POSTER 19

A curious example of NIV exacerbating acute on chronic hypercapnic respiratory failure

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[1] *University College London Hospitals NHS Trust, Fleet, United Kingdom*

Summary A 61 year old female with a past medical history of HIV infection and previous pulmonary tuberculosis (TB) was admitted to a university hospital through the Accident and Emergency department with hypercapnic respiratory failure. She was a never smoker, her HIV was well controlled (currently taking antiretroviral therapy), and the TB was successfully treated in 2004. Following recent review at another hospital she had been prescribed furosemide. Despite this, she described a7 day history of increasing breathlessness and her initial blood gas showed a compensated hypercapnic respiratory failure; ABG: pH 7.435, pCO2 8.31, pO2 6.10, HCO3 38.2, BE 17.6, sO2 80%, FiO2 21%. Despite management of a preliminary diagnosis of pulmonary oedema, over the following days there was no improvement in her gas exchange. Lung function tests demonstrated obstructive lung function, but on decompensation into a respiratory acidosis, NIV caused an increase in PaCO2 despite achieving adequate minute ventilation.

Background Our patient attended A&E with a 7 day history of deteriorating breathlessness on a background of several years of stable breathlessness, which had not been investigated. She presented with bilateral leg swelling, initial chest radiograph demonstrated cardiomegaly and an NT-proBNP was significantly elevated (2700pg/ml). An ECHO demonstrated significantly dilated right ventricle with impaired overall RV function, tricuspid regurgitation and significantly raised pulmonary pressures. An atrial septal defect (ASD) was present with suggestion of left to right flow. A CTPA was conducted due to a raised D-dimer;

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there was no pulmonary embolus, but a small right sided pleural effusion was identified with widespread patchy ground glass opacities. A preliminary diagnosis of pulmonary oedema secondary to heart failure caused by ASD was made.

Diuresis was initiated, with subsequent improvement in pleural effusion and peripheral oedema. However, her hypercapnia did not significantly improve and she remained breathless despite normalisation of her PaO2 and peripheral oxygen saturations. A referral to the Respiratory Ventilation team was made.

Respiratory assessment On review, it was noted that her oxygenation was variable, though without clinical correlate. Specifically, there was no relation with body position, nor evidence of platypneoa/ orthopnoea. It was also recognised that when hypoxic, supplemental oxygen significantly improved PaO2 (FiO2 0.21: pO2 5.38, FiO2 0.24, pO2 7.74) making the likelihood of an explanatory cardiac shunt unlikely. Review of the CT thorax images showed significant mosaicism. Though this was initially thought secondary to pulmonary oedema, the lack of improvement with diuresis raised the possibility that this represented either pulmonary hypertension or bronchiolitis. We proceeded to pulmonary function testing.

Testing revealed significant airflow obstruction (FEV1 0.47, Z score -4.48, FVC 1.28 z score -23.68 FEV1/FVC 34.68, MEF 50 Z score -3.46, MEF25 Z score -3.11) and VC > FVC. Lung volumes demonstrated gas trapping (Va/TLC 0.48, RV Z score 4.48) and gas transfer demonstrated markedly reduced alveolar volume (score 35 -6. and preserved kCO (0.77). It was considered that the predominant pathology demonstrated was small airways disease.

She was initiated on inhaled ICS/LABA and cardiology opinion regarding ASD management was sought.

However, within 48 hours, she clinically decompensated and developed an acidotic hypercapnic respiratory failure. An NIV trial was commenced though due to the known ASD it was considered that this risked reversing the shunt causing right to left flow, and worsening the hypercarbia. We therefore performed ECHO during NIV initiation whilst monitoring peripheral oxygen saturations (SpO2) and transcutaneous pCO2 (TcCO2). With the introduction of NIV (ST mode, IPAP 10 cmH2O, EPAP 4cmH2O, rise time 300ms, inspiratory time 1.2 seconds, back up rate 12bpm) tidal volumes of 6ml/kg (IBW) were achieved (appropriate given her reduced FEV1 at spirometry). However, echocardiography revealed that on introduction of NIV the cardiac shunt reversed, with a deterioration in SpO2 (FiO2 0.24, pre NIV SpO2 93%, during NIV SpO2 80%) and increase in TcCO2 (pre NIV 9.5kPa, during NIV 9.95kPa). NIV was therefore discontinued.

A new ECHO with bubble contrast was completed which demonstrated a patent foramen ovale (PFO) with bidirectional flow.

It was considered that NIV caused reversal of shunt due to increasing right ventricular afterload by way of applied positive pressure on a background of high intrinsic PEEP secondary to small airways disease. This therefore ruled NIV as inappropriate treatment when this patient was acutely compromised. Her case was discussed with a tertiary cardiology centre but it was considered that operation was precluded given the progression to pulmonary hypertension.

A treatment plan targeting the pulmonary hypertension was made with the introduction of Sildenafil, and renal filtration to manage acidosis. Sildenafil was chosen due to antiretroviral medication interaction with other options.

Further echocardiograms were completed to observe the changes following introduction of Sildenafil which showed a mild to moderate improvement in tricuspid regurgitation. The right to left shunt was no longer easily visible and left and right ventricle outflow tract velocity time integral were seen to have improved, improving the overall cardiac output. Her blood gas indices subsequently improved; FiO2 0.24, pH 7.399, pO2 7.64, pO2 8.42, HCO3 35.5.

Once stable, she was studied to assess her oxygen requirement when mobilising and any associated changes in pCO2. She was assessed on a defined walking circuit, whilst attached to a transcutaneous CO2 monitor on mobile plinth. She was noted to desaturate significantly on exertion, corrected with 1L/min oxygen via nasal cannula. At this flow rate there was no discernible rise in TcCO2.

We proceeded to assess her nocturnal oxygen requirement. Oximetry studies were conducted on 1L oxygen due to daytime requirement) Mean SpO2 was 97% with a total of 5% of the study time spent below 90% SpO2 from a 7 hours study. An early morning CBG returned the following values: pH 7.382, pCO2 9.92, pO2 7.70, HCO3 39.8, BE 19.1, sO2 91%.

An LTOT prescription was made for Oxygen at 1L/min flow rate.

She was discharged from hospital with a prescription for bumetanide alongside inhaled ICS/LABA.

After a one month period, an outpatient review was made was completed. It was noted her peripheral oedema had improved. . She has been using her oxygen as prescribed and felt symptomatically better with little changes to her blood gases; SpO2 of 92%. ABG: pH, 7.410, pCO2 8.74, pO2 6.68, HCO3 37.3, BE 16.9, FiO2 21%.

Currently remains on Sildenafil for pulmonary hypertension awaiting cardiac review.

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Discussion This complex case highlights the importance of understanding underlying physiology in cases of respiratory failure. We used a combination of radiology, lung function testing, ECHO and transcutaneous gas monitoring to understand the interplay of multiple physiological derangements before appropriate treatment could be instituted.

We identified a significant ASD with bidirectional flow in the setting of severe airflow obstruction owing to small airways disease. We considered it likely that the small airways disease contributed significantly to the pulmonary hypertension and variable oxygenation, rather than the latter being caused by right to left shunt alone. This is supported by the significant improvement in oxygenation demonstrated with small increments in FiO2.

This pathological picture does not constitute Eisenmenger's syndrome due to the airways component, and lack of significant persistent hypoxia (or associated polycythaemia) which would be expected in Eisenmenger's where shunt direction reverses after a threshold of pulmonary pressure is passed due to chronic right ventricular volume overload).

The aetiology of her small airways disease was not elucidated. Though bronchiolitis is recognised in HIV, this is usually in the setting of high viral load, which we do not believe our patient to have suffered following diagnosis. It is conceivable that she developed bronchiolitis before diagnosis, but persistence with good control of viral loads is unusual. Given her complex cardiopulmonary pathophysiology lung biopsy was considered too high risk.

This case serves as a useful reminder of the potential impact of NIV on cardiac function in all settings, and the importance of recognising potential deleterious effects. Whilst we had the benefit of understanding the potential risk of NIV in this setting and could therefore proactively assess its impact, the case demonstrates the importance of monitoring responses to NIV and considering cardiopulmonary responses, rather than pulmonary alone.

POSTER 20

The establishment of a website for lung function laboratory document management

Mr Aidan Laverty[1], Ms Kirstie Rogers[1], Mr Elliott D'Souza[1]

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The establishment of a website for lung function laboratory document management

Introduction Management of laboratory documentation e.g. standard operating procedures (SOPs), policies, checklists, feedback and audit forms, becomes problematic with increased numbers of documents. Daily lung function laboratory duties rely on ready availability of such documentation but can be subject to multiple versions by different authors across different network locations.

Aims To develop a user-friendly system allowing easy viewing and retrieval of lung function laboratory documentation.

Methods A hypertext markup language (HTML)/Cascading Style Sheet (CSS) website was developed using a freeware text editor. The website displayed the following categories:

- 'The Tests'; SOPs, reporting policy, patient leaflets and reference literature (Figure 1)
- 'Quality & Safety'; Calibration/BioQC, Operational Quality and website links to Hospital-wide policies
- • 'Audit & Monitoring'; Daily checklists and audit forms
- • 'Patient'; Friends & Family, patient surveys
- • 'Administration'; laboratory meetings, staff training, annual report
- • 'Societies'; links to external websites e.g. ARTP, ERS

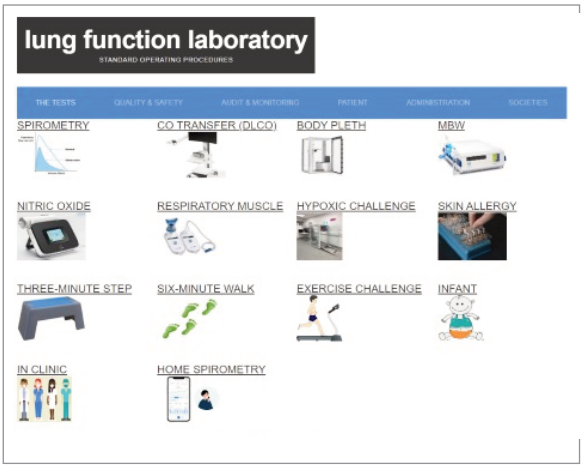

Figure 1: website homepage

Results Since implementation (2021), the website is used routinely to easily access audit, monitoring and patient forms. It also serves as a teaching aid for new staff, who are shown the site during induction. Establishment of the website, in association with an IQIPS accreditation bid, helped establish procedures for standardising and naming documents, version control and retention of legacy files. Laboratory processes are streamlined, allowing fast access to documents in one location, quick review of SOPs during clinical practice and avoidance of use of legacy document versions.

Discussion The website depends on hyperlinks remaining current. Consistent document naming helps maintain this for laboratory-based documents, facilitating minimal

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website maintenance. External links e.g., hospital-wide policies are subject to change, although links tend to remain consistent, other than in site-wide change. The website is not a full document management system, but when used in conjunction with electronic calendar reminders can be used as one in a smaller department.

POSTER 21

Has the Introduction of the GLI Spirometry Reference Equations Significantly Changed the Predicted Values for ILD Patients at Glenfield Hospital?

Miss Eleanor Davies[1]

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Introduction: Reference equations are used in spirometry to produce a predicted value for an individual, based on their age, height, sex and ethnicity. This provides context to spirometry results by allowing the comparison of the achieved result against the predicted result. There are numerous reference equations available, such as the European Community for Coal and Steel (ECCS) equations which were used at Glenfield Hospital prior to April 2021, and the Global Lung function Initiative (GLI) equations which are currently used. Spirometry is a useful tool in monitoring disease progression of Interstitial Lung Diseases (ILD's), a group of lung disorders that cause fibrosis of the parenchyma. A subtype of ILD, Idiopathic Pulmonary Fibrosis (IPF), can be treated with antifibrotics of which eligibility includes having a Forced Vital Capacity (FVC) of between 50% and 80% of predicted when performing spirometry (NICE, 2018). The aim of this study was to investigate whether the change from the ECCS to GLI predicted equations had significantly altered the predicted spirometry values for a group of ILD patients at Glenfield Hospital

Methods: Data was collected retrospectively from the spirometry database stored on the Medical Graphics Breeze Suite software at Glenfield Hospital. A total of 3143 tests were available and an inclusion criteria was applied which included: a formal ILD diagnosis, accurate and reproduceable spirometry performed on both the Breeze Suit software using GLI values and the ExpAir equipment using ECCS equations. This resulted in a study population of 56 patients. Due to the relatively small population and lack of representation of certain ethnicities, it was not possible to take a sample.

Results: The difference in mean FVC% between the two reference equations of 4.6% was significantly different. Caucasian females were affected the most when converting to GLI, with an average FVC% decrease of 10.97% (figure1). The only group to experience an average increase were non-Caucasian males with an average FVC% improvement of 1.49%. The proportion of patients eligible for antifibrotics was significantly different when using the two different reference values, with 24 patients eligible using ECCS which increased to 30 patients when using GLI.

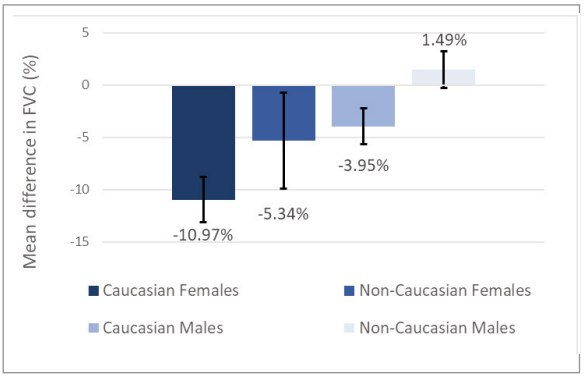

Figure 1: The mean difference in FVC% when changing from using ECCS to GLI predicted values. In both of the female groups, there was an average drop in FVC% of 10.97% and 5.34% for Caucasians and non-Caucasians. There was also an average decrease of 3.95% for Caucasian males. The non-Caucasian males on average had a higher FVC% using GLI compared to using ECCS reference values.

Conclusion: The mean FVC% for this study population was found to be significantly less (-4.6%) when using GLI predicted equations compared to ECCS. Caucasian females were affected the most by the change in predicted equations, whereas non-Caucasian males experienced the least change. When investigating potential effects on treatment, 6 (11%) patients became eligible for antifibrotic treatment who would not have been if ECCS was still being used, due to their decrease in FVC%.

POSTER 22

Diagnostic utility of Cardiopulmonary Exercise Test (CPET) in patients with unexplained breathlessness

Mr Christopher Harding[1]

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Introduction: Cardiopulmonary exercise testing (CPET) is a diagnostic tool widely used in the investigation of unexplained breathlessness. This study investigated the outcomes of all CPETs performed within our department in patients referred with unexplained breathlessness and/or those with increased levels of breathlessness out of keeping with baseline investigations. We aimed to determine the proportion of patients in which CPET identified a breathing pattern disorder and whether this impacted their functional capacity.

Methods: 332 CPETs were performed in 2021-2022 to

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ARTP 2021 standards following their referral for unexplained breathlessness. Outcomes were categorised by their subsequent diagnosis, then further categorised by whether the tests were maximal or sub-maximal and then finally categorised as to whether the patient achieved a normal peak oxygen consumption (VO2peak) or not.

Results: From the 332 CPETs performed, 166 (50%) reassuringly demonstrated no abnormalities, 126 (38%) demonstrated breathing pattern disorders (BPD) and 40 (12%) demonstrated pathophysiology. Cases that demonstrated BPD were further sub-classified into those demonstrating hyperventilation (52 (41%)) and those that did not (74 (59%)). 74% BPD cases without hyperventilation demonstrated normal VO2peak compared to only 27% of patients who had accompanying hyperventilation in tests that were performed to a maximal level. Occurrence of a reduced VO2 peak was significantly more likely in patients with DPB accompanied with hyperventilation ($P < 0.01$).

BPD N = 126							
BPD – Hyperventilation N = 74				BPD + Hyperventilation N = 52			
Maximal N = 42		Sub-maximal N = 32		Maximal N = 37		Sub-maximal N = 15	
Normal VO2 peak	Reduced VO2 peak	Normal VO2 peak	Reduced VO2 peak	Normal VO2 peak	Reduced VO2 peak	Normal VO2 peak	Reduced VO2 peak
N = 31	N = 11	N = 15	N = 17	N = 10	N = 27	N = 6	N = 9

Conclusions: CPETs provide definitive assurance of the presence of BPD in patients already on a referral pathway for unexplained breathlessness with normal baseline investigations. CPET not only distinguishes between BPD phenotypes to aid clinicians in treatment but provides evidence of aerobic limitation that will impact an individual's exercise capacity. Patients who demonstrate BPD accompanied with hyperventilation are more likely to have a reduced aerobic capacity.

POSTER 23

Cardiopulmonary exercise testing (CPET) and N-terminal pro-brain natriuretic peptide (NTproBNP) testing in the assessment of heart failure.

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Background: Cardiopulmonary Exercise Testing (CPET) is used to identify heart failure (HF) patients with poor functional capacity that have the greatest clinical need and potential to benefit from heart transplant (Mehra et al. JHLT 2016; 35: 1-23). Another test used to guide HF management is the blood plasma concentration NTproBNP, a hormonal marker of cardiac wall stress. Previous studies have identified significant relationships between CPET variables and NTproBNP, with some suggesting that NTproBNP may be used to predict CPET performance (Krüger et al. JACC 2002; 40: 718-722). Wythenshawe HF service performs prognostic assessments in selected patients, which includes both CPET and NTproBNP testing.

Aims:

1. To assess the proportion of patients referred for HF assessment that meet established CPET criteria for transplant eligibility.
2. To investigate the relationship between CPET variables and NTproBNP, including whether NTproBNP can be used to predict CPET performance in relation to transplant eligibility criteria.

Method: 123 consecutive HF assessments between 01.01.2019 – 01.09.2021 were retrospectively analysed against well-established transplant eligibility criteria from CPET. Univariate correlations were performed between CPET variables and NTproBNP using Spearman's rank test. Receiver Operating Characteristic (ROC) curves were calculated to assess whether NTproBNP could be used to predict CPET performance in relation to transplant listing criteria.

Results: Transplant listing recommendations based on CPET consist of multiple criteria. The number of patients that met these criteria were as follows:

1. Peak VO2 ≤12ml/kg/min in beta blocker tolerant patients from a maximal test = 4/69
2. Peak VO2 <50% pred. in young (<50) or female patients from a maximal test = 4/33
3. VE/VCO2 >35 = 19/68

Significant correlations were observed between the CPET variable in each of these groups and NTproBNP. (Group 1: $r = -.45$, $p<0.01$, $n= 69$. Group 2: $r = -.43$, $p<0.05$, $n = 33$. Group 3: $r = .36$, $p<0.01$, $n = 68$).

NTproBNP was able to predict CPET performance in relation to transplant eligibility criteria, with excellent (group 1) to fair (group 3) discriminatory power (Group 1: AUC = 0.87, 95% CL 0.74 - 1.0. Group 2: AUC = 0.80, 95% CL 0.76 – 0.99. Group 3: AUC = 0.70, 95% CL 0.55 – 0.85).

Conclusion: Few patients referred for prognostic HF assessment were eligible for transplant based on CPET. There is a clear association between CPET performance and NTproBNP in patients with HF. Furthermore, in carefully selected patients, NTproBNP may be used to predict whether CPET results are likely meet transplant eligibility criteria.

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POSTER 24

Assessment of Obstructive Sleep Apnoea with Peripheral Arterial Tone (PAT) Technology

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Introduction: Obstructive sleep apnoea/hypopnoea (OSAH) can be diagnosed using with variety of technologies. Oximetry alone can yield a false negative and a more robust polygraphy study is often then recommended before the decision to treat with CPAP is made. We sought to determine if oximetry data plus detailed clinical history is sufficient for the decision to treat.

Methods: Patients who undertook oximetry and subsequent WatchPAT over 12 months were screened. 58 patients were included and 17 proceeded to CPAP after the WatchPAT study. Oxygen desaturation index (ODI), mean SpO2 and the Apnoea/Hypopnoea Index (AHI) data were compared using Spearman-Rank (for correlation), Wilcoxon signed-rank (for average difference) and Bland-Altman (for agreement). The decision to trial CPAP was made independently by a Clinical Scientist based on oximetry plus clinical data (Epworth, reported sleepiness, snoring, witnessed apnoeas, morning headache, total sleep time) and compared to a previous decision by a Clinician who had additional WatchPAT data.

Results: Oximetry ODI and WatchPAT AHI did not correlate. There was a moderate correlation for mean SpO2 between oximetry and WatchPAT ($r2 = 0.6879$, $p < 0.001$). A strong correlation was observed between WatchPAT ODI and WatchPAT AHI ($r2 = 0.9975$, $p < 0.0001$). There were no significant differences on average between any parameters compared. However, Bland-Altman plots demonstrated that WatchPAT yields a higher value for AHI compared to Oximetry ODI (mean difference 5.5). The decision to treat with CPAP based on oximetry plus clinical data versus an additional WatchPAT yielded the same number of patients (17 total), although there was only 71.9% agreement between the two methods.

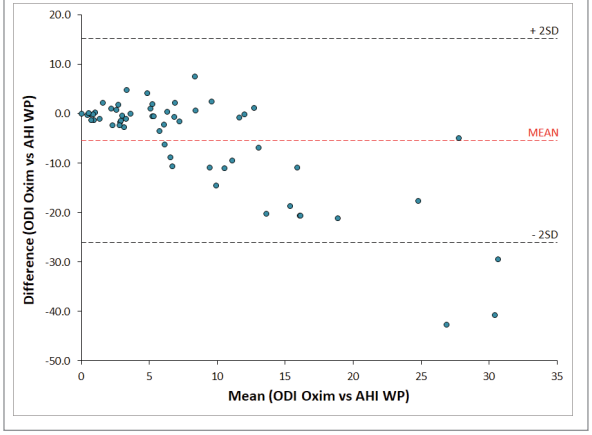

Figure: A Bland-Altman plot comparing the primary diagnostic parameters from Oximetry (ODI) and WatchPAT (AHI). On average (red dotted line), WatchPAT AHI was 5.5 events/hr higher than Oximetry ODI and this difference became larger as OSAH severity worsened. There was a significant correlation ($r2 = 0.638$, $p < 0.0001$), indicating proportional bias and, hence, no agreement between the two parameters ($n = 58$).

Conclusions: Oximetry plus clinical data alone is not sufficient for the decision to treat OSAH patients with CPAP in all cases. Indeed, WatchPAT devices have been so successful, they have now replaced oximetry as our first-line diagnostic study.

POSTER 25

The impact of not starting therapy in clinic during CPAP initialisation: a retrospective cohort study

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Introduction: Obstructive sleep apnoea (OSA) is a condition where the upper airway is compromised whilst asleep, with continuous positive airway pressure (CPAP) as the gold standard treatment. For CPAP to be effective, an adequate mask seal is essential which is determined during initialisation by fitting a mask and trialling CPAP. During the COVID-19 pandemic, as CPAP was classified as an aerosol-generating procedure (AGP), patients were unable to trial CPAP in clinic.

Methods: A retrospective search identified patients initiated on CPAP in May-September 2019 (pre-COVID-19) and May-September 2020 (post COVID-19). Values of average daily CPAP usage (minutes) and excessive or non-excessive mask leak (≥24 or <24 litres/minutes respectively) at 30 days post CPAP initiation were collected for the first 100 patients in a consecutive series in both groups.

Results: An independent T-test was carried out on CPAP usage and found a non-significant decrease in average CPAP usage in 2020 (mean 314 ± 121 minutes) compared to 2019 (mean 327 ± 129 minutes), $p=0.487$. The chi-square test of homogeneity was conducted on mask leak and showed a non-significant increase in the proportion of patients with excessive mask leak in 2020 (28%) compared to 2019 (20%), p value=0.185. Multiple regression analysis of age, sex, AHI, ESS and mask leak, showed that these factors collectively did not statistically significantly predict CPAP compliance $F(5,194)=2.031$, $p=0.076$. As an individual factor, sex was statistically significant and predicted CPAP usage of 44 minutes less in males compared to females (table 1).

Conclusions: In our patient cohort there was no significant impact on mask leak or short-term CPAP compliance since

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CPAP usage 2019 and 2020	B	95% CI for B LL	UL	Sig	SE B	β	R^2	ΔR^2
Model							.050	.025
Constant	349.515	246.052	452.978	.000	52.459			
Sex	-44.437	-83.209	-5.666	.025	19.658	-.169		
Age	.169	-1.219	1.556	.811	.703	.018		
AHI	.392	-.377	1.161	.316	.390	.072		
ESS	-1.453	-4.706	1.801	.380	1.650	-.065		
Mask leak	-29.715	-72.481	13.051	.172	21.684	-.102		

Model = "Enter" method in SPSS statistics; B = unstandardised regression coefficient; CI = confidence interval; LL = lower limit; UL = upper limit; Sig = coefficient significance; SE B = standardised error of the coefficient; β = standardised coefficient; R2 = coefficient of determination, ΔR2 = adjusted R2

Table 1: Multiple regression model for 2019 and 2020 collectively

the procedure change in CPAP initialisation which contrasts with Turnbull et al., Thorax 2022;77:839-841 who found a significant decrease in CPAP usage. Whilst the regression model was not statistically significant, male sex was associated with decreased predicted CPAP usage.

POSTER 26

Change in lung clearance index (LCI2.5) following initiation of Elexacaftor/Tezacaftor/Ivacaftor (ETI) in children with Cystic Fibrosis (CF) aged 6-11 years

Mrs Jody Jolly[1]

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Objectives: LCI2.5 has been extensively used in research trials for CF therapies, although use in routine clinical practice is limited. Elexacaftor/Tezacaftor/Ivacaftor (ETI) was licensed for UK use in January 2022 for children aged between 6-11 years with CF and any FDA approved mutation combination. This single-centre, cohort study aimed to analyse the effects of ETI on lung health (LCI2.5) as well as spirometry and growth measures.

Methods: Baseline data prior to commencing ETI were collected for children with CF including anthropometric data, spirometry data (Vyntus One, Carefusion) and LCI2.5 by nitrogen multiple breath washout (Exhalyser-D, Eco-Medics). These measurements were then repeated after 3 months of ETI treatment at the next clinic visit.

Results: Data are available for 11 children (8 male), of whom 4 were modulator naïve and 7 had transitioned from prior modulator treatment (3 from Ivacaftor and 4 from Symkevi). At baseline, the mean age was 10.2 years (7-12), LCI2.5 was 6.9 (5.8-8.9), FEV1% predicted was 97% (74-122) and BMI was 19.1 (16.1-26).

Differences in clinical parameters before and after starting ETI are displayed in Table 1.

Conclusions: A trend towards improvement in $LCI_{2.5}$ and FEV_1 following commencing ETI therapy. There was a statistically significant improvement in BMI. Potential reasons for not demonstrating statistically significant improvements in $LCI_{2.5}$ and FEV_1 including small sample size and pre treatment values close to normal indicating good baseline lung health. Recording $LCI_{2.5}$ in the clinical setting appears a useful outcome for assessing changes in lung health in CF. $LCI_{2.5}$ is a good tool in tracking lung health over time.

	Pre-ETI	Post-ETI	Mean (SD) change	p-value*
LCI2.5	6.9 (1)	6.4 (0.3)	-0.52 (0.9)	0.09
LCI z score	+1.4 (2.9)	+0.2 (0.9)	-1.3 (2.7)	0.15
FEV_1 (% predicted)	96.9 (14.1)	101 (12.3)	+4.2 (9)	0.18
FEV_1 (z score)	-0.3 (1.2)	+0.1 (1.1)	+0.35 (0.8)	0.22
FVC (% predicted)	102 (14)	103 (12)	0	0.98
FVC (z score)	0.2 (1.2)	0.2 (1.0)	0	0.85
BMI	19.1 (3.6)	19.9 (3.9)	+0.8 (1.1)	0.04

*Student's paired t-test

Table 1 Mean (SD) differences in clinical parameters before and after ETI therapy

POSTER 27

The Oxygen pulse response during cardiopulmonary exercise testing in our paediatric cystic fibrosis population.

Mrs Colleen Carden[1], Mr Paul Burns[1], Mr Scott Tart[1], Dr Ross Langley[1], Dr Philip Davies[1]

[1] *Royal Hospital for Children, Respiratory & Sleep Physiology, Glasgow, United Kingdom*

Objectives: Children with Cystic Fibrosis (CF) undergo annual cardiopulmonary exercise testing (CPET) at our centre as part of their routine assessment. It had been noticed that several were showing an abnormal Oxygen pulse response (O_{2pulse}) with a flattening or fall at higher intensity exercise. Oxygen pulse has been demonstrated to be a good marker for stroke volume. Our aim was to evaluate the CPET results from our CF subjects to check for the incidence of an abnormal O_{2pulse} response.

Methods: This was a retrospective analysis of clinical data obtained during CF patient's annual reviews. They underwent spirometry, static lung volume measurements (Vyntus body – Vyaire Medical) and a CPET using an incremental maximal ramp protocol performed on a cycle ergometer (Vyntus ONE CPET – Vyaire Medical).

Results: Data was analysed over an 18 month period. There were 63 patients tested. The demographics,

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pulmonary function and CPET results are shown in the table below. 32% (20 patients) exhibited an abnormal O_{2pulse} response. Of these, 40% had a reduced aerobic capacity (VO_{2peak} < 85% predicted). Overall, only 21% had airflow obstruction, all of which were in the mild category.

Parameter	Mean	95% CI
Sex (M/F)	42/21	-
Age	12.8	12.2, 13.3
Height z	0.07	0.24, -0.10
Weight z	0.12	0.35, -0.12
BMI z	0.07	0.37, -0.22
FEV1 z	-0.31	-0.01, -0.62
FEV1/FVC z	0.04	0.33, -0.25
VO2peak % Predicted	84	89, 80
VO2peak ml/kg	34.8	32.9, 36.7
O2 pulse % Predicted	89	100, 78
Peak HR	182	185, 179
Ventilatory Threshold (% predicted VO2peak)	47	50, 44

Table 1 Demographics PFT & CPET data

Conclusions: A high proportion (32%) of our CF patients showed an abnormal O_{2pulse} response as shown by a plateau or fall during CPET. All patients with this response had a normal baseline and stress ECG during CPET. 9 underwent a follow up echocardiogram which all showed a structurally normal heart. Further research is required to investigate the cause and clinical significance of the abnormal O_{2pulse} response in a proportion of children with CF.

POSTER 28

Assessing sub-maximal exercise in Congenital Central Hypoventilation Syndrome

Mrs Kirstie Rogers[1], Miss Mollie Riley[1], Dr Martin Samuels[1]

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Introduction Congenital central hypoventilation syndrome (CCHS) is a rare genetic condition involving impaired physiological responses to rising carbon dioxide (CO_2) and falling oxygen saturation (SpO_2) levels, and requires assisted ventilatory support at least during sleep. A recent study showed that CCHS patients with normal awake SpO_2 and end-tidal CO2 ($ETCO_2$) levels can become hypoxic and hypercapnic during a 6-minute walk (6MWT), a submaximal exercise test reflective of daily activity (Ghosh R.N. et al. 2022, Paed Pulm, 57(7), 1660-1667). Based on this study, we started to perform 6MWT routinely in patients with CCHS from July 2022, to identify those that may hypoventilate during the daytime and/or could be prioritised for phrenic nerve pacing in the future.

Method The 6MWT was performed in successive patients with CCHS following their sleep study. We monitored $ETCO_2$ on a Masimo Rad-97 with Capnography via either nasal cannula or tracheostomy using NomoLine airway adapter sets. SpO_2 and heart rate (HR) were monitored as per standard protocol. $ETCO_2$, SpO_2 and HR were recorded at baseline, 3 and 6 minutes. Measurements were assessed for change in SpO_2 and $ETCO_2$ from baseline to 6 minutes to look for hypoxaemia and hypoventilation during exercise.

Results Seven patients, median age 9.5yrs (IQR 7.9-10.9), completed the 6MWT, with ETCO2 measured via tracheostomy for 3 patients. Median 6MWD was 360m (285-405). Median change in SpO_2 during the walk was -2% (-4- -0.5) and median change in $ETCO_2$ was 6mmHg (1.5-9.5). Five out of seven patients had no decrease in SpO_2 (below 90%) or increase in $ETCO_2$ (>10mmHg from baseline) during the walk. However, one patient developed hypoxaemia with a fall in SpO2 of 16% from baseline (nadir 83%) and two showed evidence of hypoventilation on exercise with an increase in $ETCO_2$.

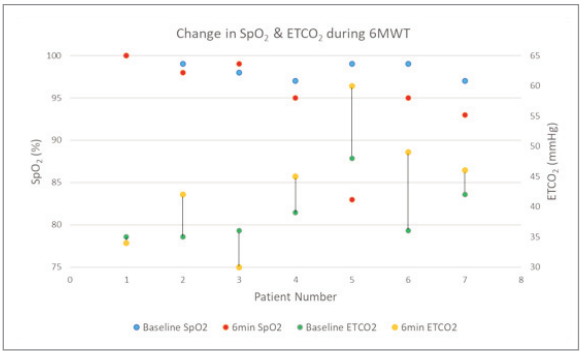

Figure 1. Comparison of baseline and 6-minute readings of SpO2 and ETCO2 for all patients

Conclusions Some individuals with CCHS may not increase their ventilation sufficiently to avoid becoming hypoxic and hypercapnic during a submaximal exercise test. This indicates a need to monitor CCHS patients during walking and specifically exercise. The 6MWT can be adapted to include monitoring of $ETCO_2$ and is an important test in the clinical care of children with CCHS managed at GOSH.

POSTER 29

Preoperative risk stratification – can we simply our approach to CPETs?

Miss Jade Aston[1]

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Introduction: Cardiopulmonary exercise tests (CPET) are a well-recognised risk-assessment tool within the preoperative setting, but the usefulness of parameters

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derived remains inconclusive. This study compared a novel approach, the Larsen method, against the current Ostiguy approach, to determine which method was most sensitive at detecting 365-day postoperative mortality.

Methods: Ethical approval was granted by MMU and UHBW. 36 thoracic and 102 upper gastrointestinal (GI) patients performed a treadmill CPET prior to surgery. Risk for surgery was calculated: (1) Larsen calculation: ln(R/(1-R)) = 7.911 – 0.052 $\dot{V}O_{2peak}$ -1.365 FEV1 produced an isopleth score which was used to produce a receiver operator characteristic (ROC) curve. (2) Predefined Ostiguy thresholds were used to assign surgery risk. Date of surgery and death were recorded to calculate mortality.

Results:

Larsen: 35 / 138 patients died by 365-days post-surgery. Isopleth value 0.6 is the most useful with a sensitivity of 66% and specificity of 53%, however, the Larsen method is poor at predicting 365-day postoperative mortality (area under ROC curve 0.629).

Ostiguy: The 95% confidence for both sensitivity and specificity are wide, showing limited effectiveness of the current Ostiguy approach.

	Ostiguy 365-day mortality		Larsen 365-day mortality
95% CI Sensitivity	18.71 – 81.29	95% (P = 0.023)	CI 0.523 – 0.735
95% CI Specificity	33.37 – 73.41	Area under the curve	0.629

Table 1: Summary of the findings showing the Ostiguy and Larsen 365-day postoperative mortality.

Conclusions: Neither the Larsen nor Ostiguy method are accurate at predicting 365-day postoperative mortality, meaning neither method supersedes the other in clinical utility. This suggests the more simplistic Larsen method may be implemented to derive surgery risk, but a larger sample is needed to examine this relationship further.

POSTER30

Inpatient lung function; timeliness and use in acute neuromuscular respiratory insufficiency

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Introduction: There are several patients admitted each year with respiratory, surgical and other acute problems. We have audited the time taken to complete lung function in these patients, with a particular focus on acute neuromuscular admissions. This latter group include Guillain Barre Syndrome (GBS), Myasthenia Gravis (MG) and Motor Neurone Disease (MND) where regular lung function has been important for determining escalation to ITU. New local guidance was written for this group which involves completing a baseline spirometry then the ward team performing a breath hold test (BHT)1 to determine any deterioration requiring further spirometry and possibly ITU admission.

Methods: All inpatient requests for lung function between 1st April and 30th November 2022 were examined for request reason and the number of working days taken to complete tests. For the acute neuromuscular group, time to breath hold test was also analysed alongside the number of spirometries and BHTs performed throughout the patient's crisis period and whether ITU escalation was required. Comparisons between BHT and forced vital capacity (FVC) were made and compared to expectation [1]. All information was taken from the PICS system which holds inpatient records.

Results: Overall, 67% of patients had spirometry completed with 1 day of the request. The mean number of days for completion was 1.3. Out of all requests, 3 patients were not tested (1 GBS, 1 respiratory and 1 other). Table 1 shows the acute neuromuscular request information. There was one outlier for the BHT, where it took 11 days to complete. For the neuromuscular patients, 1 died, 1 was escalated to ITU, but returned to the ward and the rest were discharged. Table 2 shows the comparisons between FVC and BHT and whether they correlated according to the literature[1,2].

Request reason: GBS/MG/MND	BHT performed? (%)	Median days from patient in crisis to first BHT (range)	Median no of spirometries performed over hospital stay (range)	Median no of BHT performed over acute episode (range)	Median days in crisis	Escalated to ITU
4/5/2	9 (82)	1 (0-11)	1 (1-5)	3 (0-12)	4 (2-25)	1

Table 1. Acute neuromuscular inpatient monitoring

BHT (s)	FVC (L)	expectation (L)	Agree within boundary?
26	2.81	3.5	no
9	0.9	1.5-2	no
5	1.43	1.5-2	yes
51	4.68	>3.5	yes
8	1.65	1.5-2	yes
6	1.74	1.5-2	yes
20	2.8	2.5-3	yes
10	2.02	2.0-2.5	yes
11	2.58	2.0-2.5	Almost!

Table 2. BHT versus FVC

Conclusion: Dedicated slots for inpatients would likely further improve the number of patients that can be tested within 1 working day of request. More information needs to be disseminated for the acute neuromuscular pathway to

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ensure BHT is regularly completed and instigated in a timely fashion, with further spirometry requests submitted as appropriate. BHT and FVC were comparable in 67% which may be further improved by changing to breath hold count. This can be assessed in a future evaluation.

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POSTER 31

A Service Evaluation Comparing the 'Spirobank Smart' Handheld Spirometer Versus the 'Vyntus SPIRO' Laboratory-Based Spirometer in Paediatric Cystic Fibrosis Patients

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Introduction : The use of home spirometry has recently increased due to advancements in technology and the impact of COVID-19. There have been uncertainties regarding the validity of handheld spirometers, and conflicting literature exists surrounding the agreement of handheld spirometers with laboratory-based spirometers (Barr et al., 2008; Degryse et al., 2012). This analysis was performed as the primary aim of a home spirometry service evaluation to ascertain agreement of results obtained using the MIR 'Spirobank Smart' handheld spirometer with the 'Vyntus SPIRO' laboratory spirometer.

Methods: An analysis of spirometry results was completed to compare FEV1, FVC and PEF from tests using the 'Spirobank Smart' with the 'Vyntus SPIRO' spirometer. These tests were carried out in paediatric CF patients on both spirometers during the same lab visit according to ATS/ERS guidelines (n=28). To prevent the influence of a learning effect or fatigue, the order in which device was used first was alternated. Statistical analysis involved a paired-samples sign test and Bland-Altman analysis.

Results: There were no significant differences between either the FEV1 or the FVC measurements obtained using the 'Vyntus SPIRO' spirometer compared with the 'Spirobank Smart' spirometer ($p>0.05$). There was a statistically significant difference between PEF measurements ($p=0.014$). Bland-Altman plots indicated agreement in FEV1, FVC and PEF measurements obtained from these two spirometers (refer to fig. 1).

Conclusion: This service evaluation suggests the 'Spirobank Smart' spirometer produces valid results compared with a laboratory spirometer, when performed under the supervision of a Respiratory Physiologist, with no statistically significant differences found between either the FEV1 or FVC measurements obtained. If PEF is to be considered using the 'Spirobank Smart' spirometer, caution should be taken in its interpretation due to one statistical test indicating that PEF may be overestimated.

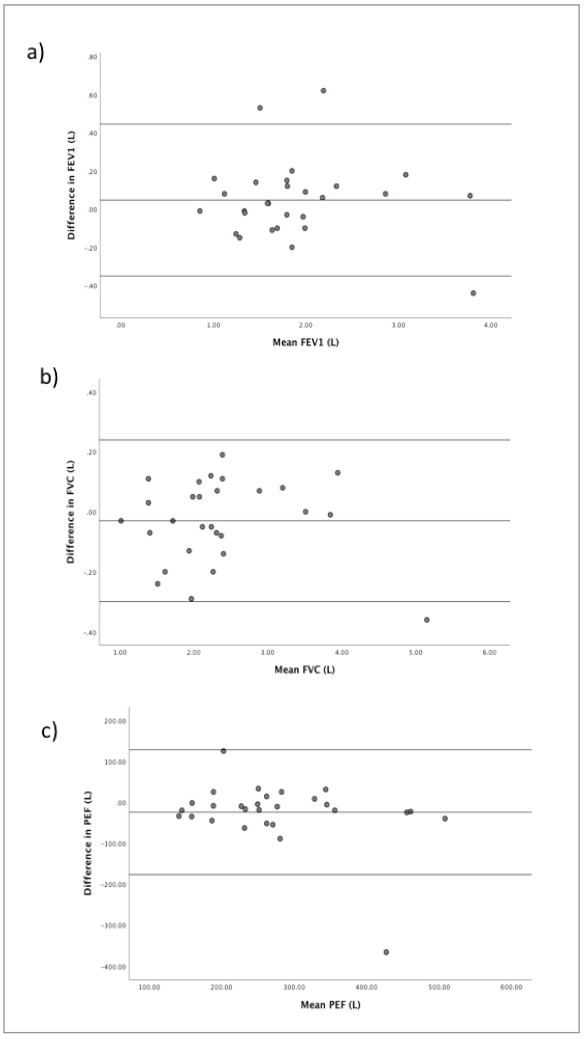

Figure 1. Bland-Altman plots representing differences in measurements obtained with the Vyntus SPIRO and Spirobank Smart spirometers expressed as a percentage of the mean difference, versus the mean of the two measurements for a) FEV1 b) FVC c) PEF

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POSTER 32

Transition to a Physiologist led Cardiopulmonary Exercise Testing (CPET) Service and evaluation of one year outcomes

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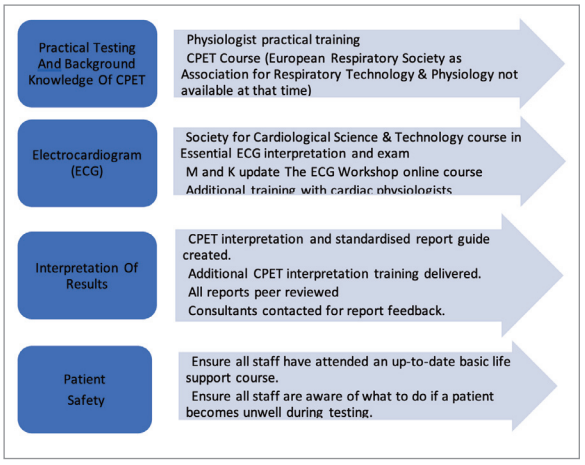
Introduction: A workforce planning initiative which was set in motion to allow transition to a physiologist led CPET service due to a number of factors.

Aims: To determine if a physiologist led CPET service can provide safe testing and interpretation.

Methods: Prior to initiation of the physiologist led CPET service the following steps needed to be performed.



One year data was collated and consultants that had requested a CPET from 28/09/2020 to 28/09/2021 were contacted for feedback, along with physiologists performing the tests (questionnaire).

Results: All staff received additional CPET training and ECG training. Between 28/09/2020 and 28/09/2021 188 patients were tested by the new physiologist led service. There were 7 relevant physiologist comments identified, none of which required medical attention. Approximately 282 hours of consultant time were saved. Consultants and physiologists rated the service as very satisfied. The majority of physiologists stated they felt safe performing CPETs autonomously.

Conclusion: Physiologists can safely perform CPETs autonomously and report to a high standard whilst saving 282 hours of consultant time.

POSTER 33

The Lung Clearance Index Core Facility

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Background: Historically, spirometry has been used in many clinical trials to obtain FEV1 for use as a well-established outcome measure. However, FEV1 is not able to detect early disease changes which occur in the smaller, peripheral airways. The multiple breath washout test (MBW), with lung clearance index (LCI) as its primary outcome, can provide an overall indication of ventilation inhomogeneity and is now used in cystic fibrosis clinical trials as a key outcome measure. The LCI Core Facility was created in 2014 to assist with standardisation of testing by certifying operators across Europe and providing an over-reading service for clinical trials.

Methods: Our team at the Royal Brompton/Imperial College have aided the standardisation of testing by working with other specialist centres to create a standard operating procedure. Training is provided to sites using a combination of online and face-to-face sessions. Operators can then submit traces for analysis whereby a well-defined set of quality criteria is applied to determine whether they pass or fail the certification. In collaboration with the cystic fibrosis clinical trials network, a log of all certified sites and operators is maintained. This allows sponsors to access a pool of suitable sites for clinical trials.

Results: To date, we have certified 206 operators; on average 78% of operators pass certification first time. We provide further training and support to those who need to re-submit. Since the core facility was established, we have overread more than 6000 MBW traces for clinical trials; this ensures high quality testing data is used in CF research.

Year	Number of operators certified	First time pass rate (%)	Total number of traces submitted
2014	12	75	38
2015	45	73	270
2016	21	67	123
2017	18	83	95
2018	23	83	140
2019	15	73	85
2020	19	74	111
2021	15	87	88
2022	15	80	83

Summary of operator pass rate

Conclusion: The LCI Core Facility has helped to enable standardisation of MBW testing, resulting in a higher quality outcome measure for CF research. Following our success, we have been approached by other disease group networks for which LCI could be a useful outcome measure.

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POSTER 34

The importance of cardiopulmonary exercise testing reference values in heart transplantation assessments

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Introduction Peak oxygen consumption (VO_2peak) expressed as % predicted, is used to risk stratify patients with heart failure (Mehra *et al*., 2016). There are various reference values available, however the Association for Respiratory Technology and Physiology recommend the Study of Health in Pomerania (SHIP) (Gläser *et al*., 2013) reference equations (Pritchard *et al*., 2021). It is unknown how the SHIP values compare to other commonly used reference values in patients with heart failure referred for heart transplantation.

Methods A retrospective analysis of patients with heart failure that underwent a cardiopulmonary exercise test (CPET) via cycle ergometry as part of a heart transplant assessment between March 2017 and November 2021 was performed. Patients were included if the CPET incremental phase duration was >6-minutes, peak respiratory exchange ratio (RER) was >1.15 and the CPET was terminated by the patient. VO_2peak % predicted was calculated using SHIP, Wasserman, Jones, and the Fitness Registry and the Importance of Exercise National Database (FRIEND) reference values and compared using a Bland-Altman analysis.

Results CPET was performed in 288 patients, of which 107 met the inclusion criteria. The mean ± standard deviation VO_2peak % predicted was 54.3 ± 14.7%, 54.6 ± 15.2%, 53.1 ± 15.6% and 47.1 ± 13.5% for SHIP, Wasserman, Jones, and FRIEND reference values, respectively. Table 1 shows the mean bias, upper limit of agreement and lower limit of agreement for VO_2peak % predicted between each of the reference values.

	Mean Bias	Upper Limit of Agreement	Lower Limit of Agreement
SHIP-Wasserman	0.2%	4.4%	-4.0%
SHIP-Jones	-1.2%	8.8%	-11.2%
SHIP-FRIEND	7.2%	12.5%	1.8%
Wasserman-Jones	1.4%	10.1%	-7.2%
Wasserman-FRIEND	7.4%	12.2%	2.6%
Jones-FRIEND	6.0%	15.4%	-3.4%

Table 1. Bland Altman analysis of mean bias, upper limit of agreement and lower limit of agreement.

Conclusions Mean VO_2peak % predicted and bias were similar between SHIP, Wasserman, and Jones predictive values, however the limits of agreement were large. The FRIEND predictive values yielded a lower VO_2peak % predicted and greater bias compared to other predictive values. The large limits of agreement amongst predictive values, further highlights the need for a coherent set of CPET reference values, to facilitate consistent interpretation of results.

POSTER 35

Quality assurance of spirometry performed by non-physiologists in a respiratory outpatients clinic

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Introduction Quality assurance and standardisation are essential to the utility of spirometry. The primary aim of this audit was to determine the compliance of spirometry tests within the outpatient department between April 2019 and June 2019. A secondary aim was to compare the relative compliance of two staff cohorts during the same period: internally trained staff (YTS) and externally trained staff (XTS).

Methods The American Thoracic Society/European Respiratory Society (ATS/ERS, 2005) guidelines were the standards used to assess technical acceptability. The Association for Respiratory Technology and Physiology (ARTP, 2000) guidelines were used to assess reproducibility compliance. A sample of 324 spirometry reports was randomly selected for analysis, based on a 95% confidence interval with a 5% margin for error. The analysis was conducted using an original data collection tool (SP1) which distilled the ATS/ERS and ARTP criteria into a series of binary appraisals, the summation of which generated a spirometry compliance classification. Each sampled report was evaluated for quality by two experienced spirometry technicians who recorded their judgements on SP1 independently of each other. The two datasets were analysed to determine the degree of inter-rater reliability, with discrepancies resolved via consensus to produce a final dataset for statistical analysis.

Results There was a high degree of inter-rater reliability. The overall departmental compliance rate with both the ATS/ERS and ARTP guidelines was 57%. The cohort analysis revealed that YTS compliance = 42% and XTS compliance = 71%, revealing a significant compliance gap of 29%. This gap widened when only technical acceptability was considered; YTS = 50%, XTS = 95%.

Conclusions The audit was presented to senior managers and respiratory consultants in the Trust. The results have

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been the catalyst for change within the department, with XTS (physiologists) now supporting the delivery of spirometry in YTS clinics.

POSTER 36
A collaboration between primary and secondary care: embracing new technology to achieve good quality spirometry

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Introduction Primary care spirometry ceased during the COVID pandemic. The reintroduction remains difficult due to concerns around workforce, commissioning and training requirements. Leeds Teaching Hospitals Trust (LTHT) does not have the capacity to offer GP direct access spirometry referrals.

A collaborative spirometry working group was created involving primary care and physiology. Funding was secured to pilot new modes of spirometry delivery by a hub model based on primary network locations.

LTHT have contributed to the operational delivery. Central to the models was the choice of equipment which allows interoperability between primary care and LTHT.

Aims The aim of this service audit was to assess whether there was any difference in quality between both models and the impact of the physiology team supporting model 1.

Model 1- Hybrid (7 GP practices with PCN)	Model 2- LTHT only (11 GP practices within PCN)
Performance of spirometry by primary care practitioner- ARTP accredited	QA delivered by LTHT staff
Quality assurance, troubleshooting, technical comments and interpretation provided by LTHT	Performance and interpretation provided by LTHT.

Table 1. Models of spirometry.

Methods 40 patient's results were randomly selected and an eight-point discrimination technique was applied to determine the overall quality of spirometry. Operator comments and interpretation from LTHT was included to explain deviation from ARTP 2020 guidelines [1] .

Primary outcomes were determined using spirometry results having been assigned an overall dichotomous value to reflect acceptable or not. Statistical analysis was performed using Chi squared tests with a significance level of 0.05.

Results Overall, 22 out of 40 spirometry tests met technical acceptability guidelines (15- Model 2, 7-Model 1). The addition of technical comments improved this to 35 out of 40 (18-Model 1, 17-Model 2).

There was a significant difference between spirometry performed by LTHT and primary care staff ($p<0.05$). This difference was obviated by technical comments and input from Clinical Scientists using technology ($p=0.23$).

Conclusion Both models have successfully reintroduced spirometry within primary care and with the support from the physiology team the quality of spirometry increases from 35% to 85% in model 1.

POSTER 37
Home cardiorespiratory sleep studies - a viable alternative in paediatrics?

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Introduction: Home cardiorespiratory sleep studies (hCRSS) are becoming increasingly utilised in the diagnosis of sleep disordered breathing (SDB). Waiting list pressures have compounded the need for alternative solutions to reduce the number of inpatient studies. The financial cost of performing home studies is significantly less than those carried out in hospital. Furthermore, patient sleep quality can be suboptimal in a hospital environment. We hypothesise that hCRSS can be used as a successful screening tool in the diagnosis of SDB in children.

Methods: A single device (SOMNOtouch™ RESP, SOMNOmedics) was utilised in a domiciliary setting within a paediatric cohort. A successful study was defined as ≥6 hrs duration and technically adequate signals. Available channels: SpO2, pulse rate, effort bands (thorax & abdomen), flow and snore (nasal cannula) and movement. Studies where SpO2, and/or effort bands were not available were classed as a failed study. SUMRIP was used as a surrogate for flow when nasal flow was unavailable. Parents attended the department on the day of the study for a demonstration of equipment application, and were given written instructions including a link to an instruction video. Physiologists were available by telephone if the family required assistance overnight.

Results: 59 patients (mean ± SD age: 8.0 ± 4.8 years with a maximum of 15.8 and a minimum of 1.0, male: 34, female: 25). Total success rate was 46/59 (78%). Flow and snore achieved in 25/59 (42%), SpO2 in 50/59 (85%) and effort bands in 52/59 (88%). 13 failed studies – 38% of failed studies had no SpO2, 23% had poor compliance, 15% were short in duration. 1 patient became unwell and 1 parent forgot to put equipment on.

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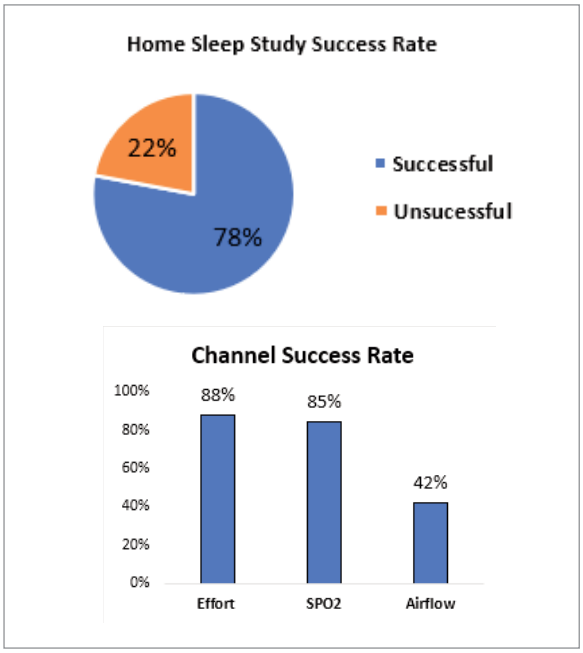

Figure 1 and Figure 2

Conclusion: Due to the high success rate, hCRSS can be used as an alternative to inpatient studies in paediatric patients undergoing investigation for SDB. The lower airflow channel success rate is due to poor patient compliance, which is also seen in supervised inpatient studies. Future work should introduce patient and parent feedback questionnaires.

POSTER 38

A review of the frequency of follow up in Sheffield Teaching Hospital Interstitial Lung Disease (ILD) patients

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Introduction NICE IPF guidelines (2017) state patients should be followed up initially every 6 months if they have stable disease by a specialised consultant. Follow-up time-frames requested by the consultant was measured against actual follow-up time, and PFTs completion to give an indication whether clinical requirements are being met. The IPF service was audited to establish if the guideline was being met.

Method Retrospective data for a 6 month period (May-October) in 2019, (pre-pandemic) and 2021 (post-pandemic) demonstrating how service provision has altered and its current level.

Once all data was complete, a series of calculation fields were added to tables to enable additional analysis of information collected through ICE. These were: outcome target date, outcome achieved, if no; days exceeded, actual days to appointment, tolerance 5%, tolerance date, achieved tolerance, tolerance days exceeded, difference apt to outcome, difference apt to tolerance outcome, days PFT conducted before follow-up, PFT follow-up achieved.

Results A total of 118 patient records were reviewed, 30 patients met their consultant outcome and 56 people met NICE guidelines of 6 monthly. Meeting targets improved overall in the 2021 cohort which could be explained due to more virtual clinics however this led to poorer alignment of PFT appointments and consultant review.

Conclusion Analysis of sample data indicates current booking processes for patients do not meet consultant requirements, highlighting current appointment booking processes in place are less than efficient and could be improved upon.

This review investigated clinical care follow-up of IPF patients, with data indicating those outcomes, and therefore patients' clinical needs are not being met as per guidance. This has clinical repercussions, with potential for condition mismanagement, delayed diagnosis and treatment intervention, and poorer patient outcomes.

POSTER 39

An audit of reproducibility standards for spirometry and gas transfer at Birmingham Heartlands Hospital

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Introduction: A large number of pulmonary function tests (PFT) are performed in our respiratory physiology department; however, we have never previously appraised how many of our tests meet ARTP quality standards.

Methods: Data was randomly selected from our local data systems between June 2021 and November 2022. We compared the outcomes of each pulmonary function test to the reproducibility standards recommended by the ARTP1, 2. Each staff member had a minimum of 5 spirometry and gas transfer tests analysed in the study period. Data is presented as frequencies and proportions.

Results: Eighty-one spirometry and gas transfer tests were included in our analysis (and 11 isolated spirometry tests). Individual criteria were all above 70% concordance with 3 parameters of gas transfer ≥90%. When combining all reproducibility criteria for spirometry, forty-nine out of 91 (53.85%) met them fully. Of the non-conformists, 15/42 had comments made as to why they weren't achieved or had maximum attempts made. Forty-one of 80 (51.3%) gas transfer tests fully met reproducibility standards (not

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including TLCO repeatability due to low numbers of available data), with 14/39 non-conformists having comments made. Table 1 shows the results broken down by each criterion. The most common reason for non-concordance of spirometry was not gaining a reproducible PEF; for gas transfer it was non-reproducible alveolar volume.

Test	Criteria	Met reproducibility criteria (n, %)
Spirometry (n = 91)	Reproducible FEV1 (within 5% or 150 mL (100 mL if < 1 L))	72 (79.1)
	Reproducible FVC (within 5% or 150 mL (100 mL if < 1 L)	68 (74.7)
	Peak expiratory flow within 0.67 L	65 (71.4)
	Back extrapolated volume < 0.1L or 5% FVC	81 (89.0)
	Expiratory time > 6sec or plateau achieved	75 (82.4)
Gas transfer (n = 80)	Alveolar volume within 5% (or 10%)	56 (70.0)
	TLCO within 0.67mmol/min/kPa (or 10%)	29/35 (82.9)
	KCO within 0.1 mmol	64 (80.0)
	Volume inspired ≥ 90% of VC	73 (91.3)
	Mouth pressures < 3kPa	78 (97.5)
	BHT 8-12s	72 (90.0)
	Volume inspired < 2 s (or 4 s when FEV1<50% predicted)	78 (97.5)

Table 1. The frequency and proportion of PFTs meeting reproducibility criteria

Conclusion: Overall, our performance against many of the individual quality standards was positive, however, there are areas for quality improvement. Further teaching on guidelines is being implemented and a follow up audit planned.

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POSTER 40

APAP vs CPAP therapy: A retrospective analysis of clinical effectiveness and cost efficacy in the initial treatment of OSA

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Introduction: Obstructive sleep apnoea-hypopnea syndrome (OSAHS) is a significant public health burden. The latest published guidelines (NICE, 2021) recommend fixed Continuous Positive Airway Pressure (CPAP) as the first-line treatment for moderate to severe OSAS, however if the patient is unable to tolerate this, they may be transferred to Auto-titrating Positive Airway Pressure (APAP). The basis of this decision is cost, as APAP devices are more expensive to purchase than CPAP. As identified by the NICE (2021) guidelines as a key recommendation for research, this audit compares both the clinical effectiveness and cost efficacy for both CPAP and APAP trials in terms of clinical intervention instead of initial purchase cost.

Methods: 130 patients split evenly between APAP and CPAP treatment groups (n=65 each group) were retrospectively studied over the first 8 weeks of commencing therapy within two NHS hospitals. The male to female ratio was similarly distributed between groups (APAP 71% males:29% females, CPAP 77% males:33% females). Overnight pulse oximetry was used in both patient groups to screen for OSA/OSAHS. Participants with a >4% Oxygen Desaturation Index (ODI) greater than 5 per hour were included in the study, and all participants were newly referred adult patients (>18 years) who were set up on CPAP and APAP between the same 3-month period (June - August 2019) to avoid seasonal variation in compliance. Patients having already tried CPAP or APAP previously were excluded. APAP was prescribed at 4.5-20 cmH20 and CPAP pressure was fixed using a pressure prediction equation developed via departmental audit. Participant demographics, follow up cost, treatment adherence (overall percentage usage over 8 weeks and average nightly usage), mask leak and the Apnoea Hypopnea Index (AHI) were compared between groups using Mann-Whitney analysis. Optimal treatment was defined using an AHI scale <5/hr based on NICE discussion (NICE, 2021). Cost analysis for both groups were based on the NHS Agenda for Change pay scale (2019/2020) mid-point increment salary for Band 3 staff for 30 minutes with each clinical intervention required. Variability between treatment group demographics was assessed further using logistic regression analysis to exclude any correlation with treatment efficacy (AHI >5/hr on treatment) and therefore bias in results. Receiving Operator Characteristic (ROC) analysis tested the sensitivity and specificity of predicting a correlation between demographic variables in participants irrespective of whether the AHI was >5/hr or <5/hr on treatment.

Results: No statistical difference was observed between groups for AHI [p = 0.4386], nightly usage [p = 0.1193] or overall compliance [p = 0.4839]. Average mask leak was 255% greater [P= <0.0001] in the CPAP group when compared to APAP. A 57% increase in clinician intervention was observed in the CPAP group (table 1) with more interaction needed to optimise pressure in the CPAP group (n =13) compared to the APAP group (n = 6). Based on a 95% Confidence interval, demographic variability between groups for baseline ODI [P = 0.0238] and ESS [P = <0.0001] was evaluated against the likelihood of participants having

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Treatment	Pressure problem	Mask problem	Humidifier issue	Other	Total appts	Total appt cost (GBP)
APAP	6	20	4	1	28	182.65
CPAP	13	28	18	6	65	423.80

Table 1: Reported treatment interventions/ overall calculated cost per treatment mode. Greater intervention was reported overall for the CPAP group with over twice the amount of pressure amendments needed for CPAP than APAP during the 8-week trial. The CPAP group therefore generated a higher cost in terms of clinician time during the trial than the APAP group.

an AHI >5/hr on treatment. No significant predictor of suboptimal treatment (AHI >5/hr) was observed for ESS using both APAP (β1= 1.019, p= 0.7186) and CPAP (β1= 1.022, p=0.6669) with similar outcomes for ODI against an AHI >5/hr on APAP (β1= 0.01070, p= 0.3585) and CPAP (β1= 0.008138, p= 0.3660). Treatment was optimised in both groups (APAP median AHI = 3.7/hr [2.0-6.2], CPAP median AHI = 3.9/hr [1.95-7.40]). Further ROC analysis confirmed both ESS and ODI as unreliable values in predicting the likelihood of patients having an AHI >5/hr on both APAP (ESS R2= 0.002002, p=0.7158, ODI R2= 0.01293, p=0.1649) and CPAP (ESS R2= 0.002850, p= 0.4559, ODI R2= 0.01281, p= 0.3947) concluding demographic variation as irrelevant to the study outcome.

Conclusion: Results suggest overall agreement with NICE guidelines that APAP and CPAP are equally clinically effective in treatment of OSAHS, however demonstrate higher costs incurred with CPAP trials with regards to clinical commitments. There is further scope of analysis in terms of cost efficacy with the implementation of telemonitoring to facilitate treatment monitoring and providing similar levels of support in both modes of treatment for greater accuracy in conclusions. Further recommendations for research in this area would include evaluating cost beyond 8-week trials to assess the financial impact on services depending on the mode of PAP therapy used.

*Does this study use human subjects, human biopsy specimens or genetic material?** YES / NO

– Ethics committee approval was not required for this audit as all data was retrospective and anonymised. This audit did not require changing treatment/patient care from accepted standard for any participants involved. Approval was granted by both trusts' local research and development teams.

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POSTER 41

Sleep disordered breathing in children with vagus nerve stimulation therapy

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Introduction Vagus Nerve Stimulation (VNS) therapy is an effective and well tolerated treatment for refractory epilepsy in children (NICE, 2004). Reported side effects include recurrent hoarseness of voice and occasional dyspnoea, coughing and pharyngeal paraesthesia. However, studies in children have identified Sleep Disordered Breathing (SDB) in 86-89% of patients post VNS insertion (Hsieh et al., 2008; Dye et al., 2021). This study aimed to investigate presence of SDB in patients receiving VNS treatment who were referred to our paediatric sleep service.

Methods Retrospective review of medical records conducted on patients who underwent diagnostic Respiratory Polygraphy (RP) between April 2019 and December 2022 following VNS. RP was performed in accordance with the most recent American Academy of Sleep Medicine guidelines at time of recording. The presence of SDB was defined as obstructive apnoea-hypopnoea index (OAHI) ≥ 1ev/hr, and/or an unclassified AHI (UAHI) ≥ 1ev/hr, and/or a central AHI (CnAHI) ≥ 5ev/hr.

Results Five patients met inclusion criteria and were referred to the sleep service to investigate symptoms consistent with SDB. Median age at RP was 10 years (range, 6-17years). Four patients were diagnosed with SDB (mean AHI: 13.1ev/hr, range: 2.7-24.3ev/hr). Inspection of the RP demonstrated respiratory events and associated oxygen desaturations presenting concurrently with VNS on-off times and independent of sleep stage (Figure 1). Three of the patients with SDB were recommended for VNS settings adjustment.

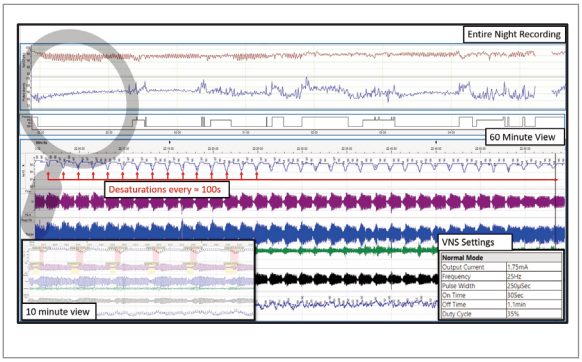

Figure 1: Entire night and 60-minute view of RP in a VNS patient demonstrating the rhythmicity of SDB and associated oxygen desaturations presenting concurrently with VNS on-off times (30s to 1.1minutes, interval=100s) and independent of sleep stage.

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Conclusion SDB is common in paediatric patients with VNS. It has a characteristic pattern presenting rhythmically, in conjunction with VNS discharges and independent of sleep stage. This study highlights the importance of assessing patients with VNS and developing management strategies such as adjustment of VNS settings or initiation of non-invasive ventilation.

POSTER 42

Using quality improvement methodology to tackle ventilator preventative maintenance adherence

Miss Emily Young[1]

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Introduction High-risk medical equipment requires planned preventative maintenance (PPM) as detailed by the manufacturer and local guidance. University Hospitals of Leicester NHS Trust face long-standing issues with high-risk PPM compliance across the 3 sites. In this area, the trust has never reached key performance indicator (KPI) of 90% adherence set by medical physics and the trust board. This has been highlighted as requiring improvement by CQC under regulation 12 and sits on the risk register due to increased probability of adverse events associated with device negligence.

Non-invasive ventilators, provided to patients for long-term domiciliary use, fall into this category of high-risk devices. The ventilation team at one site were encouraged to increase PPM adherence of non-invasive ventilators to contribute towards the trusts' improvement efforts.

Aims To reduce the number of non-invasive ventilators from the GH site with outstanding PPM from 21% to <10% by April 2022.

To develop a viable, long-term approach to limit devices with outstanding PPM to <10% of those in circulation.

Methods A small focus group was formed to address this issue of safety, comprising:

1. A medical engineering representative
- A respiratory physiologist specialising in ventilation
- The department's equipment room team leader (assistant physiologist)
- A colleague with an interest in quality improvement methodology.

Previous attempts to reduce the number of devices outstanding (visible in graph 1) were reviewed. This involved staff unable to take part in full clinical duties (due to shielding etc.) organising ad hoc maintenance appointments and device swaps. This was found to be unsustainable on their return to normal clinical duties and was felt to not address the underlying issues.

A plan-do-study-act (PDSA) approach was agreed upon. Behaviour change theory was used to match barriers to suitable interventions based on the behaviour change wheel (Michie et al. IS 2011; 6:42). This theory splits problems into areas of:

1. Knowledge
2. Motivation
3. Opportunity.

QI tools identified knowledge and as the primary obstacle. Clinical staff were not fully aware of the requirements for ventilator maintenance, nor the regulations involved.

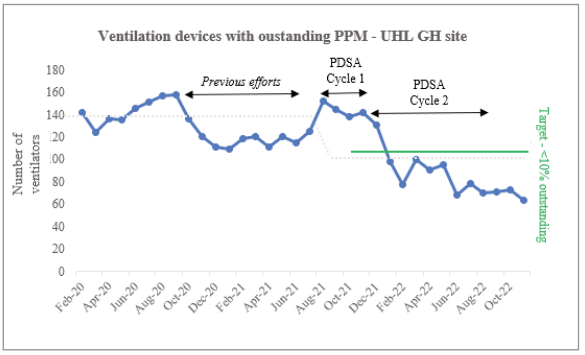
In PDSA cycle 1, a bundle of associated changes targeting knowledge was implemented, including:

- Education for staff
- Visual reminders
- Engagement with the medical engineering team
- Alert system on clinic interactions.

Despite raised awareness, opportunity for staff to swap devices to enable PPM to occur remained limited. Therefore, in PDSA cycle 2, a dedicated team member was tasked with organising PPM as part of their role. Organisation included:

- Telephoning patients who had routine clinical review pending ensure attendance
- Booking ventilator maintenance appointments for all other relevant patients (appointments now factored into the standard working week).

Results



Graph 1: Run chart of monthly number of ventilators from the GH site with outstanding PPM from Feb 2020-November 2022.

Educating staff around the importance and relevance of device maintenance in PDSA 1 appeared to prompt a downward trend in overdue devices. However, this was not felt to be significant enough to achieve our target in a timely manner. It was found that despite heightened awareness, standard patient contacts were not frequent enough in non-complex patients to offer timely maintenance.

PDSA cycle 2 saw an improvement 'shift' according to Institute for Healthcare Improvement run chart rules. This

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appears stable in recent months. The changes made in PDSA 2, namely embedding this task into a job role and regularly rostered ventilator maintenance appointments, have been fixed into normal practice. Increasing staff awareness of maintenance requirements still forms part of our training process.

Conclusions

1. Quality improvement methodology, incorporating behaviour change theory, contributed towards addressing this issue of PPM non-compliance within our department.
2. Early data suggests that the current approach, now factored into our standard working week, may be sustainable. This model may demonstrate for others the time required for organising PPM within a ventilation service: locally 14 hours/month for a service of 750 adult patients (1042 devices at time of writing).
3. Work in conjunction with medical physics is required to refine data collection to allow for direct evaluation of % of devices outstanding, permitting control charting. Currently this figure is deduced (although number of devices is relatively stable).
4. Sustainability appears to require strategies embedded into job roles and standard practice. Methods reliant on individuals' solo efforts were not only unmaintainable, but also unquantifiable and unrecorded.
5. Patient voice is required to understand the acceptability of additional appointments for PPM.
6. Lack of appreciation of all processes involved before commencing dampened QI efforts.

POSTER 43

How well does pre-operative cardiopulmonary exercise testing predict hospital length of stay, 30-day, 90-day, 1-year and 2-year post-operative mortality?

Mr James Penrose[1], Mr Adrian Kendrick[1], Mr Mark Hardyman[1], Mrs Carla Thomson[1], Mr Liam Bagley[2]

[1] University Hospitals Bristol And Weston NHS Foundation Trust, Bristol, United Kingdom, [2] Manchester Metropolitan University, School of Healthcare Science, Manchester, United Kingdom

Introduction: Numerous guidelines advocate the use of cardiopulmonary exercise testing (CPET) prior to major surgery however it remains unclear which indices best predict surgical outcomes. A combination of absolute V̇O2 peak, V̇O2 peak.kg, anaerobic threshold (AT) and O2 pulse are commonly used to determine "overall" risk for surgery.

Methods: 109 patients were retrospectively identified via an electronic patient information system. Hospital length of stay (LOS) and survival time (if deceased) were calculated. Pairwise comparisons of Kaplan Meier curves and Mantel Cox log-rank tests were performed to determine if hospital LOS, 30-day, 90-day, 1-year, and 2-year mortality were significantly different ($P<0.05$).

Results: Primary analysis indicated the "overall" risk classification had no effect on hospital LOS, 30-day, 90-day, 1-year and/or 2-year mortality ($P\geq0.05$). Secondary analysis revealed neither the absolute V̇O2 peak, AT or O2 pulse risk classification impacted hospital LOS 30-day, 90-day, 1-year and/or 2-year mortality ($P\geq0.05$). As for the V̇O2 peak.kg risk classification groups; no significant difference was observed at 30-days, 1-year and/or 2-years ($P\geq0.05$). Analysis of hospital LOS suggested very high risk individuals had a significantly shorter LOS than low and intermediate risk individuals ($P<0.05$). Conversely, analysis of 90-day mortality suggested a survival advantage for lower risk patients; with low risk individuals surviving longer than intermediate/high risk individuals and intermediate risk patients surviving longer than intermediate/high and high risk patients ($P<0.05$).

Conclusion: This study suggests that the "overall" risk classification and the four primary parameters used to determine it poorly predict hospital LOS, 30-day, 90-day, 1-year and 2-year mortality. Further research should aim to identify which CPET indices and thresholds best predict surgical outcomes and if these are consistent across all types of surgery

ORAL PRESENTATION 1

Respiratory physicians collaborate with explainable artificial intelligence for improved diagnostic interpretation of pulmonary function tests

Marko Topalovic[1], Nilakash Das[1,3], Julie Maes[1], **Camille Vanhecke**[1], William D-C. Man[2], Wim Janssens[3]

[1] ArtiQ NV, Leuven, Belgium, [2] NIHR Respiratory Biomedical Research Unit, Royal Brompton and Harefield NHS Foundation Trust and Imperial College, London, United Kingdom, [3] Laboratory of Respiratory Diseases and Thoracic Surgery, Department of Chronic Diseases Metabolism and Ageing, KU Leuven, Leuven, Belgium

Introduction: Many Artificial Intelligence (AI) validation studies often compare AI against a reference standard, typically a human expert. However, few studies have investigated the collaborative potential between AI and the reference standard. In this study, we investigated whether explainable AI software could improve the diagnostic performance of respiratory physicians in the interpretation

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of pulmonary function tests (PFTs).

Methods: We recruited 62 experienced respiratory physicians from across Europe. Each physician was provided with 24 PFT reports and asked to provide a preferential and up to 4 differential diagnoses based on PFT data alone. Physicians were blinded to the established gold-standard respiratory diagnosis established by an expert panel with access to all medical notes and investigation results. Each PFT was interpreted first without and then with explainable AI suggestions (ArtiQ.PFT). The primary endpoints were preferential and differential diagnostic accuracy. Secondary endpoints were the number of differential diagnoses, the diagnostic confidence, and the inter-rater agreement.

Results: Physician + AI had significantly higher preferential (18.12±2.22 vs 15.62±2.02 improvement) and differential (20.5±2.2 vs 22.83±1.34 improvement) diagnostic accuracy compared with physicians alone (Figure 1). All secondary endpoints showed improvements. Respiratory physician reduced their number of differential diagnostic choices slightly. They updated their decision roughly 50% of the time. Finally, we observed that respiratory physicians were unlikely to follow the AI's incorrect suggestion, which indicates low automation bias.

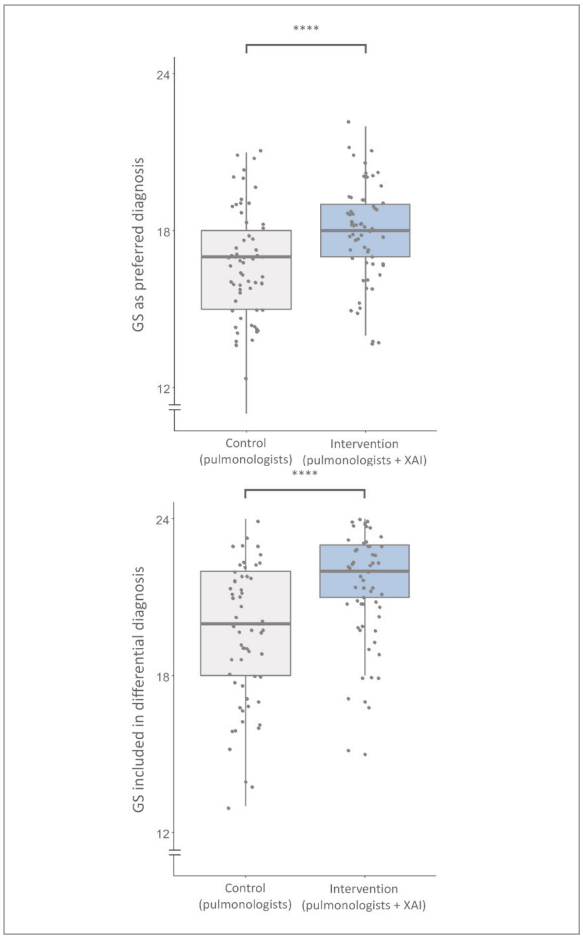

Figure 1. Primary endpoints (preferential diagnosis accuracy, left) and secondary endpoints (differential diagnosis accuracy, right) for AI software (with artificial high proportion of mistakes), pulmonologists and teamwork (pulmonologists supported by the AI software).

Conclusion: In conclusion, a collaboration between respiratory physicians and AI (ArtiQ.PFT) is superior at interpreting PFTs when compared to individual respiratory physicians.

ORAL PRESENTATION 2

Comparison of a flow volume analysis model against a human panel - A pilot study

Mark Unstead[1], Mrs Jessica Swan[1], Emily Seaman[1], Lise Sproson[2], Dr Ian Cliff[3]

[1] Royal Berkshire NHS Foundation Trust, , United Kingdom, [2] Devices for Dignity, NIHR, Sheffield, UK, [3] University Hospitals of North Midlands NHS Trust, Staffordshire, UK

Introduction Numerical spirometry measurements have been used to define abnormality for some time. Analysis of the flow volume loop allows unique patterns to be identified but is less established outside of respiratory medicine. The purpose of this pilot study was to assess the performance of a graphical data model.

Method A Flow volume Analysis Model (FAM) was constructed including a 100 point model of analysis, area under the flow volume curve and pattern of flow decline after peak flow. The FAM was run on 50 examples. Cases compatible with various abnormalities (detailed in Table 1) were also scored by a Human Panel (HP). The HP was made of various roles including consultant physicians, registrars, junior doctors, physiologists, physiotherapists, and physician associates (n=22, experience: 8 years, range: 2-31 years). For the purposes of creating a predicted curve, normal limits were taken from GLI dataset for Volume (FVC) and from ECSC for maximal flows. Ease of scoring and perception of automated spirometry analysis was assessed with a questionnaire using a 0-10 score.

	Abnormality evident on Flow Volume Loop (FVL)									
	'Normal'			'Restriction'		'Obstruction'				
	A	B	C	D	E	F	G	H	I	J
Human:	96	96	82	77	77	96	68	82	68	91
Model:	100	100	100	100	80	100	100	80	80	60

Key: A: Preserved FVL with normal FVC. B: Preserved FVL with supra-normal FVC. C: Preserved FVL with reduced FVC. D: Mild obstruction on FVL with reduced FVC. E: Severe obstruction on FVL with reduced FVC. F: Mild obstruction on FVL with normal FVC. G: Moderate obstruction on FVL with normal FVC. H: Severe obstruction on FVL with normal FVC. I: Moderate obstruction on FVL with supra-normal FVC. J: Upper Airway Obstruction (UAO).

Table 1: Percentage of cases correctly classified by human and model flow volume loop scoring

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Results

The most prevalent mistake in the HP cases involved classification of mild and moderate obstruction. The most common error in the FAM was scoring UAO as severe obstruction.

Perceived ease of scoring task was inversely related to experience with a wide range. Support of automatic FVL analysis implementation in primary care and secondary care was neutral. The use of automated analysis to assist human interpretation was positively supported.

Conclusion Both FAM and HP were relatively successful at identifying examples of normal shaped FVL. The FAM outscored the HP in most cases. More modelling data is required to improve automatic scoring of UAO and severe obstruction.

Reference

1. Ioachimescu et al.,(2022) J Investig Med;70:1247–1257.

ORAL PRESENTATION 3

Increased diagnostic information from multiple night oximetry in diagnosis of obstructive sleep apnoea

Mr Harry Kirby[1], Dr Emma-James Garden[1], Dr Anne McGown[1], Mr Mark Unstead[1]

[1] Royal Berkshire Hospital, Reading, United Kingdom

Introduction The NICE guideline for obstructive sleep apnoea (OSA) has moved away from use of screening oximetry to home respiratory polygraphy on cost effectiveness grounds, but does not comment on single vs multi-night studies. Our centre perform multiple night oximetry on the basis that OSA may be missed on the first night due to equipment acclimatisation, and we could postulate this may be a bigger problem for multichannel studies. We looked at how many treatment decisions would be altered if only the first night data is used to make clinical decisions.

Method 206 patients who attended for overnight oximetry were included in the analysis. The study was performed over two nights in their own home, measuring oxygen desaturation index (ODI) and mean pulse rate.

Results 27.6% of patients saw a change in category between the two nights. Of the 71 patients with a normal ODI from the recordings taken over both nights, 5 of these were offered multi-channel sleep studies. Of these 5 patients, 4 had a normal ODI (<5) and one had moderate OSA (ODI 15.43). Table 1 provides a breakdown of the results, including whether CPAP was trialled.

Conclusion The use of multi-night oximetry highlights variability over two nights, with an increase (14.5%) and decrease (13.1%) in severity. This variability has also been demonstrated in multichannel studies (Lebon et al1). The additional information from the second night influences whether patients undergo a CPAP trial or are managed conservatively. We would advocate the use of multiple night sleep studies as providing additional diagnostic information guiding treatment in a significant proportion of patients.

Night 1	Night 2	Number	CPAP trial offered
Normal (ODI <5)	Normal	71 (34.5%)	1 (1.4%)
Normal	Mild (ODI 5-<15)	19 (9.2%)	5 (26.3%)
Normal	Moderate/severe (ODI 15->15)	0	0
Mild	Normal	13 (6.3%)	3 (23.1%)
Mild	Mild	29 (14.1%)	16 (55.2%)
Mild	Moderate/severe	11 (5.3%)	10 (90.9%)
Moderate/severe	Normal	1 (0.5%)	1 (100%)
Moderate/severe	Mild	13 (6.3%)	11 (84.6%)
Moderate/severe	Moderate/severe	50 (24.3%)	47 (94.0%)

Table 1: Pulse oximetry results including CPAP trials (N=206)

Character count (not including table) – 1657

Reference

1. Le Bon O, Hoffmann G, Tecco J, Staner L, Noseda A, Pelc I et al. Mild to Moderate Sleep Respiratory Events. Chest. 2000;118(2):353-359.

ORAL PRESENTATION 4

CPET to identify breathing pattern disorders in children with exertional dyspnoea

Miss Natalie Jayne Orr[1], Charlotte Richardson[2], Hope Zied[3], Samantha Sonnappa[4]

[1] Royal Brompton Hospital, London, United Kingdom

[2] Chief Respiratory Physiologist, Royal Brompton Hospital, London, United Kingdom

[3] Paediatric Respiratory Physiologist, Royal Brompton Hospital, London, United Kingdom

[4] Paediatric Respiratory Consultant Royal Brompton Hospital, London, United Kingdom

Introduction: Patients are referred to the paediatric CPET service for evaluation of “shortness of breath on exertion”. The causes of exercise induced dyspnoea are several fold and identifying the cause is important to facilitate correct treatment pathways and reduce the need for inappropriate treatment escalation (Goddard and Sonnappa. PRR 2021; Vol 38. Page 24-32). Breathing pattern disorders (BPD) are increasingly recognised as a cause for exertional dyspnoea. Altered breathing patterns can significantly affect a patient’s exercise tolerance, ability, and their overall quality of life. (Barker et al. 2020; Front. Paediatrics. 8:379).

Objective: To ascertain the prevalence and pattern of BPD’s, in our paediatric cohort.

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Methods: We retrospectively analysed CPET data since inception of our paediatric CPET service in June 2022. To better distinguish the relationship between breathing frequency and tidal volume, we use the graph as displayed in the figure.

Results: Data from 40 patients was analysed, (18 male; median age 13yrs, range 9-16yrs), (22 female; median age 14yrs, range 8-17). 32 (80%) were noted to have a BPD and referred for specialist respiratory physiotherapy for assessment and breathing retraining. The outcomes for the remaining 8 patients were varied, but included exercise induced bronchoconstriction, physical deconditioning, and symptom monitoring. Three predominant altered breathing patterns were identified in our patients (Fig 1b, c, d).

These examples are indicative of dysfunctional breathing, and their sub-optimal breathing patterns may be significantly impacting their exercise performance.

Conclusion The prevalence of BPD is high in the children and young people referred for CPET for exertional dyspnoea. Plotting of tidal volume and breathing

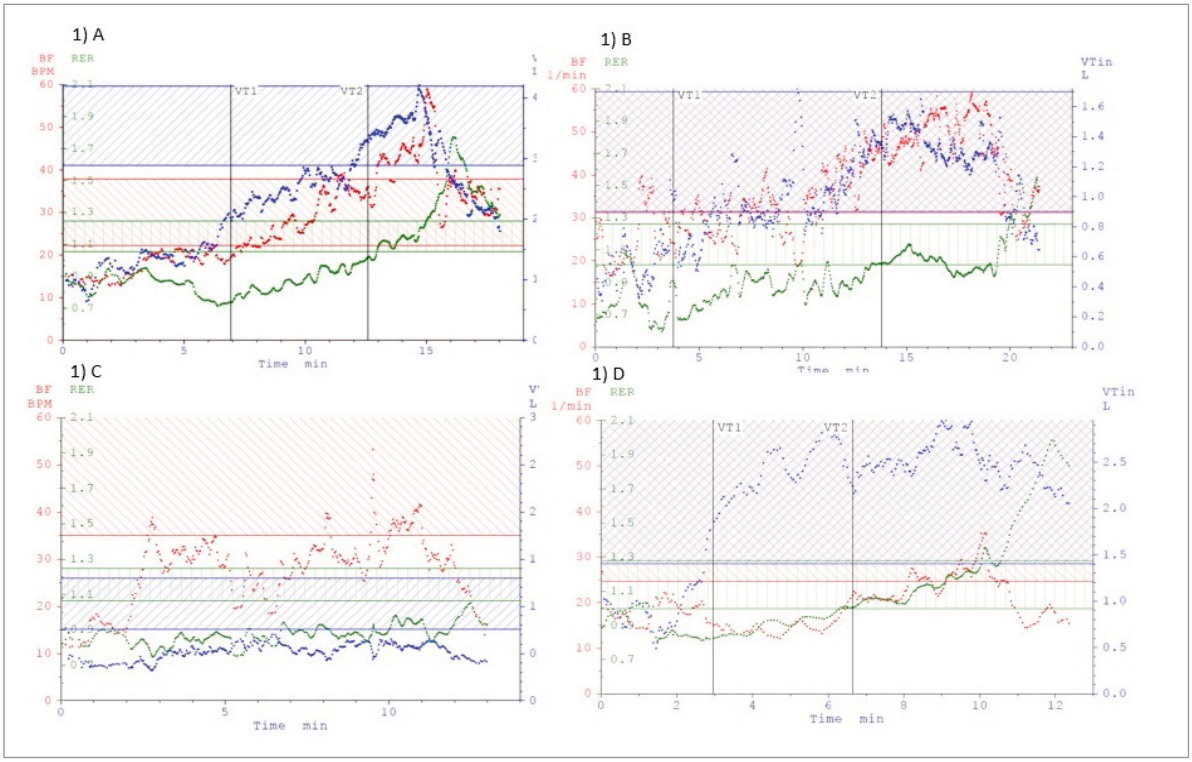


Figure 1. Examples of breathing patterns in response to exercise. Graphs demonstrate the relationship between breathing frequency and tidal volume. A) Normal tidal volume and breathing frequency in response to exercise; B) Erratic breathing frequency and tidal volume throughout exercise; C) Stunted tidal volume and erratic breathing frequency in response to exericse; D) Large tidal volumes throughout exercise with no compensatory hyperventilation

CONFERENCE PICTURES

2023 Awards

















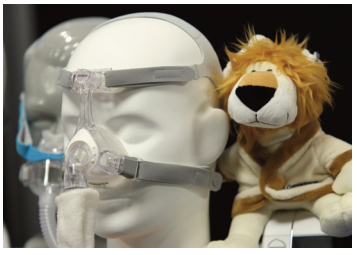


The full gallery can be viewed at www.artp.org.uk/2023-annual-conference

CONFERENCE PICTURES

Exhibition Pictures



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General conference pictures












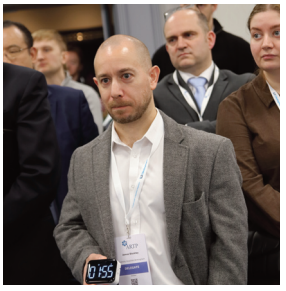
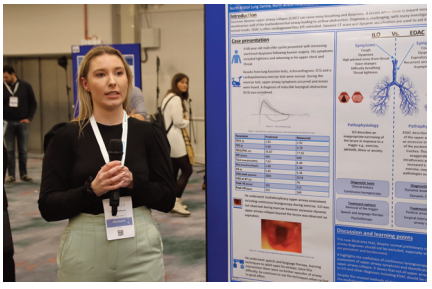
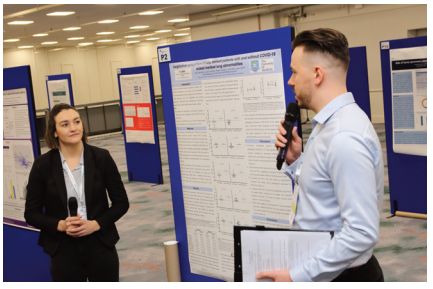

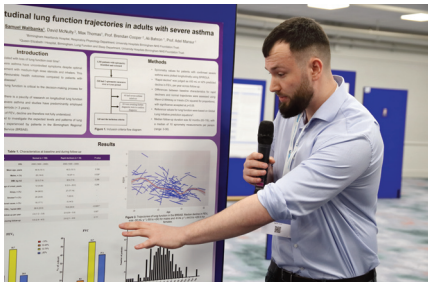

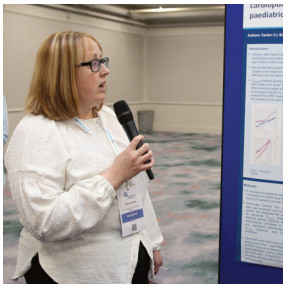

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ARTP AGM MINUTES

Thursday 16th March 2023 Hilton Brighton Metropole Hotel

Chair: Julie Lloyd

1.0 Welcome

1.1 Julie Lloyd (JL), ARTP Honorary Chair, welcomed the audience and outlined the agenda for the AGM and the annual report that had been sent to all members prior to the AGM.

1.2 JL thanked the Board and the Council Members for their hard work this year.

2.0 Review of the ARTP Annual Report

2.1 JL gave an overview of the Annual Report, which had been made available to members before the AGM. JL reminded those present of the membership categories that have voting rights. All eligible members present voted to accept the Annual Report with no objections.

3.0 Membership report

3.1 JL informed a slight increase in total members from 2021, this was likely due to the reintroduction of face to face events and attracting new members. JL confirmed that numbers of renewed ARTP members remains stable.

4.0 Financial report -Presentation of the Balance Sheet and Financial Statement for the year ended 31st March 2022

4.1 JL reported that the Statement of financial activity shows that the total funds are significantly higher than 2021, showing a significant recovery from the loss incurred during the pandemic. JL thanked Mike Lang for his excellent work during the pandemic and the current financial position.

4.2 JL reminded those present of the membership categories that have voting rights. All eligible members present voted to accept the Accounts with no objections.

4.3 JL expressed acknowledgements for the support of the membership and manufacturers.

4.4 JL gave her thanks to Mike Lang (ARTP Treasurer) and to Executive Business Support (ARTP Support Services).

5.0 Officers for Election

5.1 JL expressed thank to our Officers standing down, Sara Parsons ARTP Sleep Chair, Dr Jane Kirkby ARTP Paediatrics Chair and Kelly Pauly ARTP Events Chair.

5.2 JL advised that Incoming Officers are Andrew Morley ARTP Sleep Chair, Emma Fettes ARTP Paediatrics Chair, Laura Jess ARTP Events Chair, Matthew Rutter ARTP Standards Chair.

5.3 JL advised on a number of different committee opportunities and encouraged any member wishing to join a committee to get in touch.

6.0 Trustees:

6.1 JL confirmed there were no changes to the Trustees or positions that required a membership vote.

7.0 AOB

7.1 JL asked if there were any questions from the membership. No questions were raised.

Close

JL brought the AGM to a close.

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