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ARTP Association for Respiratory Technology & Physiology

Inspire

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FIRST WORD

VOLUME 22, ISSUE 2. AUGUST 2021

Welcome to the summer Inspire and I hope you are keeping well. I don't know what to say about holidays this year but I have gone with a bright colour scheme for this issue to lift us (or maybe it's only me) out of any 'new normal' doldrums.

Like many of us, I registered for the virtual ARTP conference, in early July. As it took place during my working hours I found it difficult to focus, what with phones ringing, colleagues in my office etc. - which shows the value of being able to devote time to conference. However the beauty of the format was I could view most of the presentations later on. I eventually caught up, as the site was active until the end of the month, and found it to be yet another well organised and informative event. (and I am not just saying that!). The chairing of the sessions was particularly good and the Q&A format improved matters further. Additionally, many of the manufacturers sponsored some excellent Industry Workshop Sessions, which are listed in 'On the Blower '. Congratulations to all. Just some of the things I discovered (checks notes) were: diagnostic hubs used to deal with hospital referrals, which are "a different way of delivering things". I heard that "spirometry is dead" (or maybe not), that garlic bread may be the future and that a Sherpa can run down a mountain carrying an arterial blood sample quicker than most. The 'fundamentals' sections should be required viewing (and available) for all and that radio waves can be used to track our H_2O-filled bodies remotely without the need for sensors. Finally, there was talk of "The Matrix" possibly featuring two of our most esteemed colleagues and I watched the innovative use of a virtual poster to display the presenter wearing a wide range of his favourite shirts. This issue contains the abstracts of all the posters from the conference, which are introduced as part of 'Fresh Air'. The minutes of the Annual General Meeting can be read on Page 46, here.

Away from the conference, we have part two of Kevin Hogben's 'how it works – body plethysmography' - see the previous issue of Inspire if you need to catch-up! There is the entertaining round-up of the ARTP forum since April in 'Top Forum'. The 'Word from the Chair' keeps us up to date on ARTP goings-on (if any) in the month since conference. The paediatric laboratory at GOSH (which I happen to know very well!) achieved UKAS/IQIPS accreditation and you can read an interview about the preparation and ramifications on Page 14, here.

Finally, ARTP are looking for Regional Leads, to help improve regional networking. Read more on Page 24, here.

My thanks, as always, go to the contributors and Editorial Committee.

Until the next issue...

Aidan Laverty

Julie Lloyd

ARTP Honorary Chair

A WORD FROM THE CHAIR

Welcome to the summer edition of your ***Inspire*** journal, although for many of us, the weather has been doing an excellent job of convincing us that it is not summer! We recently had a storm with ping-pong ball sized hailstones bouncing around the garden!

With talk of summer, for the first time in ARTP history, we held our delayed Annual Conference in the summer months. This marks a huge change from our normal post-Christmas event. As another first, it was also the first fully virtual Annual Conference hosted by ARTP, building on the success of the virtual National Strategy Day that was held in October last year. The virtual format provided ARTP to invite leading experts from all over the world, including Professor Bruce Thomson from Australia, Professor Stefano Nava from Italy, Dr Sanja Stanojevic from Canada, Professor Chris Imray from the UK and Professor Jeroen Swart from South Africa. Many of these speakers kindly presented at very unsociable hours or were live for the Q&A to give delegates the opportunity to interact with them. The feedback that we have received is very promising and we will use this to help us shape the format of future ARTP Conferences. The ARTP Conference was also an opportunity to present our ARTP Special Awards and I was delighted to see ARTP present the Medic award to one of our keynote speakers, Professor Stefano Nava. He gave an inspiring presentation of his personal journey with Covid-19, which he contracted during the first wave, and about the work he has continued to do managing Covid-19 patients during the pandemic. Our ARTP Scientist award was presented to Sandra Davies from Cwm Taf Morgannwg University health board, Wales. Sandra was nominated by several ARTP members for her huge contribution to the education and training of respiratory and sleep scientists in Wales and the UK and she is the former Chair of the ARTP Examinations Committee. I would like to extend my personal congratulations to both Stefano and Sandra.

So to this edition of Inspire … Kevin Hogben completes his excellent two-part review of the theory and practice of body plethysmography. This article is definitely a ‘must read’ for physiologists and scientists new to plethysmography and an excellent refresher for those of us with more experience.

We have an excellent interview from Martyn Bucknall, Chair of the Accreditation Clinical Advisory Group (ACAG) for IQIPS who spoke to with Emma Fettes, IQIPS Lead at Great Ormond Street Hospital about their recent successful IQIPS Accreditation inspection. This should really give all ARTP departments the impetus to take their own IQIPS accreditation

process forward and I'm sure that those departments who have successfully completed this process would also be happy to provide support and guidance.

As if this wasn't enough, Dr Harry Griffin has compiled a review of the key issues that have been discussed on our lively ARTP Forum, along with the responses that were submitted. Hopefully, this will make it easier to quickly locate the answer to that burning question that you have! Finally, our ARTP Research Chair, Dr James Stockley, has collated the abstracts from the ARTP Conference in research and innovation section of Inspire, 'Fresh Air'.

As we move in to autumn, many of us will be eagerly anticipating the European Respiratory Society Congress, which is being held in a virtual format 5th – 8th September. This looks like another exciting meeting, presenting the absolute best in respiratory and sleep medicine and an opportunity to network with colleagues from across the world.

Enjoy the remaining weeks of summer and I look forward to seeing many of you at the upcoming ARTP virtual National Strategy Day, which is scheduled for 12th November. I will leave you all on that positive note and I hope you enjoy this edition of ***Inspire***. As always, I look forward to continuing to work with you all as your Chair and hearing your thoughts for the future directions of ARTP.

ON THE BLOWER

Matt Rutter
Alan Moore
Prof. Brendan Cooper

There were not many manufacturer submissions for 'On the Blower' this issue, probably because most of the manufacturers were present virtually at the recent ARTP conference, where you had the chance to 'visit' them and view videos of their products.

Many of them also hosted excellent virtual workshop sessions, as listed below.

Click on the logo to be taken to the manufacturer website.

Thursday 1st July 2021, 08:30-09:00

Fisher & Paykel HEALTHCARE

An update from F & P, what's new and where next?

intermedical

How to improve indoor air quality with portable air purifiers

NUVOAIR

NuvoAir Home: Self-monitoring of lung health for people with respiratory conditions

ResMed
Changing lives with every breath

Digital pathways for Sleep and Respiratory Care during COVID and beyond

Vitalograph®

Implementation of the ATS/ERS Standardization of Spirometry 2019 Update

Friday 2nd July 2021, 08:30-09:00

CIRCASSIA

The importance of FeNO in Asthma

Jazz Pharmaceuticals

Excessive Daytime Sleepiness (EDS) in drivers with obstructive sleep apnoea: A patient-centred, physiologist-led conversation

SomnoMed

Tools to build a business case for Oral Appliance Therapy in the treatment of OSA

vyaire MEDICAL

Introduction to Tidal Breathing Analysis Using Impulse Oscillometry

Sponsored Sessions			
Fundamentals of Gas Transfer	Vitalograph	Back to the Fundamentals of Physiology	Stowood
Introducing Diagnostic Hubs into Service Delivery	SomnoMed	Interventional Pulmonology	Vyaire
Diagnosing Paediatric Patients at Home	Intermedical	Sleep Keynote Session	Radiometer
P K Morgan Memorial Lecture	Circassia	Technological Advances in Sleep	Jazz Pharmaceuticals
Poster Presentations	Vyaire	Where is Lung Function Going: a global view?	Medical Graphics
Covid-19 Session	Fisher & Paykel	How is Innovation Going to Change Lung Function	Itamar Medical
Global Lung Initiative	ResMed		

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Vitalograph®

A Global Leader in Respiratory Diagnostics

Thank you!

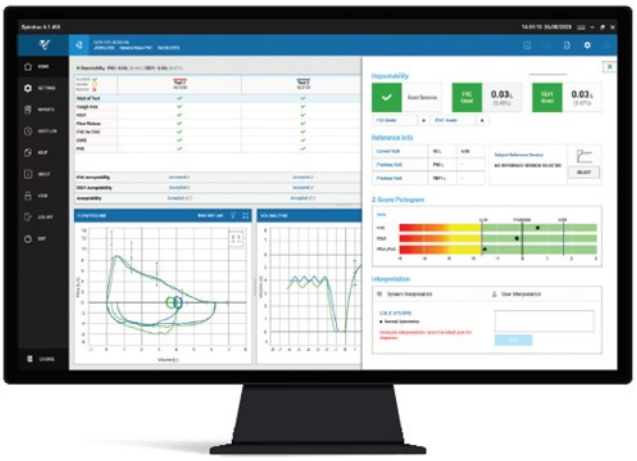
We would like to thank everyone who attended our workshop and visited us at the recent ARTP Virtual Conference. Once again, the ARTP put on a high-quality programme.

The event was another fantastic opportunity for Vitalograph to showcase some of our latest

Ensuring you are compliant with the latest 2019 ATS/ERS guidelines

We were excited to showcase fast, easy, and accurate spirometry with the launch of the next generation Vitalograph **Pneumotrac™** PC-based spirometer combined with **Spirotrac® 6** software and the **Alpha** desktop spirometer with fast, integrated printer.

The next generation Pneumotrac Spirometer, combined with Spirotrac PC software, is a powerful tool for respiratory diagnosis of both adults and paediatrics. Capture reliable test results immediately with Pneumotrac's precise and durable measuring technology which is extremely accurate and stable over time



- FVC and FEV1 Grading System as per latest ARTP/ERS 2019 guidelines
- Graphical representation of Z-score values to facilitate interpretation
- Advanced incentive options

New Alpha encompasses compliance with the ATS/ERS 2019 spirometry guidelines, multiple testing options, quick loading integrated thermal printer and direct links to Vitalograph Device Studio via USB to generate PDF reports. It is easy to link to your EMR systems using Ethernet or WiFi.

As standard each device comes with **Vitalograph Connect**, our innovative Electronic Medical Records connectivity solution. Provided free of charge, this configurable kit provides direct connection to your EMR using HL7.

Pneumotrac and Alpha come with **FREE 5 YEAR WARRANTY** and **FREE ONLINE DEVICE TRAINING**.

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The **Vitalograph® Eco BVF™** range combines independently validated 99.999% bacterial and viral cross-contamination efficiency for medical personnel, patients and equipment, with a reduced environmental impact because less plastic is used in manufacturing. Both the cross contamination report and certificate are available on request.

The range is suitable for most major manufacturers of spirometers and pulmonary function equipment. Kits are available to include Eco BVF, nose clip and bite on mouthpiece combination options. The range also includes an extended 'Bite-Lip' design for added comfort.

FeNO

Vitalograph has added the Bosch Vivatmo FeNO devices to our range. Featuring the **Vivatmo pro** with base station, and **Vivatmo me**. These feature the same unique sensor technology which requires neither calibration nor replacement. With high-precision sensors, these Bosch devices represent excellent value for money.

New Faces

We are pleased to welcome our new UK Application Specialist, Charlene Mhangami, to the Vitalograph UK Healthcare support team. Charlene joins us from Nottingham University Hospitals NHS Trust and will be responsible for customer product/clinical training and support. She is available via **01280 827875** or **charlene.mhangami@vitalograph.co.uk**.

Get The Latest Updates

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How it Works

Body Plethysmography

By Kevin Hogben

Part Two

Continued from Part 1, in the previous issue of *Inspire*.

There are several constructions for the Body Plethysmograph, this is well described in a presentation in 1974 to the National Heart and Lung Institute by David Leith and Jere Mead.

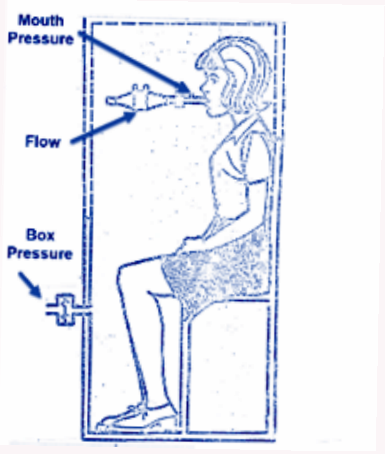


Figure 1. Pressure plethysmograph. The subject breathes on an assembly incorporating mouth pressure tap, shutter and flowmeter. Pressure transducer provides volume information.

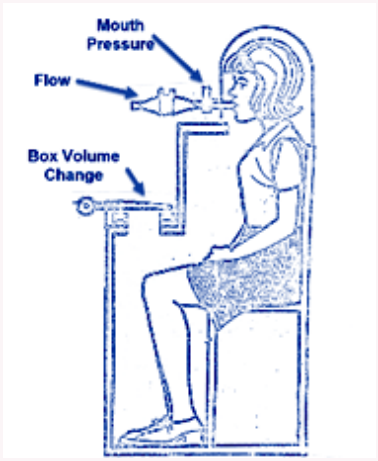


Figure 2. Volume plethysmograph. A displacement transducer on the spirometer provides volume information.

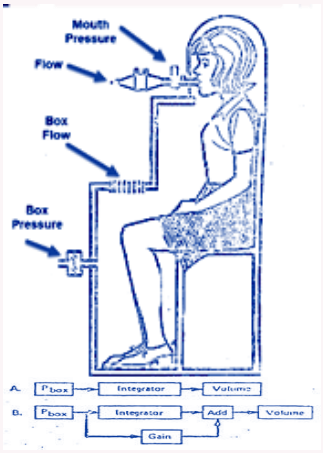


Figure 3. This integrated-flow plethysmograph is a volume box if used as shown in A, or a pressure-volume box if used as shown in B. Pressure transducer provides flow and volume information.

Today the Constant Volume change in Pressure cabin (**Figure 1**) is the most widely used type, here the box pressure is calibrated by means of a sinusoidal pump, delivering a low volume, the resulting change in pressure is adjusted for temperature and ambient pressure and then converted back to represent the original volume. The subject re-breathes from within the cabin environment and the mouth pressure is measured with an occlusion valve.

This type of cabin is designed with a controlled leak that is set to be outside of the frequency response of the measurement and therefore a NULL effect on the Box pressure measurement. The leak is necessary as the subjects core temperature starts to warm the box volume once seated in the closed cabin, this rising temperature increases pressure and if not allowed to leak away would present a drift on the box measurements, similarly the ambient pressure can fluctuate and then this “leak” enables the box pressure / Volume to remain constant.

A general rule is a small subject can be tested very soon after closing the door, this is because they displace only a little of the total box volume (approximately 1000 litres), the remaining air is then increasing in temperature slowly and outside of the time constant of the measurement, it is insignificant.

* This article is the author’s personal view and not all devices are covered.

Please email the editor at inspire@artp.org.uk if you would like to write a history of your favourite(s).

The large frame subject displaces a lot of total volume and the remaining small volume is heating very quickly and would present a drift on the box pressure signal. This type of subject typically needs as much as two minutes to reach thermal equilibrium. Some manufacturers apply algorithms to bias the changing box pressure signal whilst this enables measurements to start more quickly it is not a substitute for temperature equilibrium.

In areas where there are wide fluctuations in Ambient pressure, or pulsatile air conditioning, then a Compensation box can be used; this is no more than a chamber with one open to atmosphere port and a line to connect to the Box pressure transducer ambient port, this then balances any ambient pressure fluctuations to the box pressure transducer and results in a null effect.

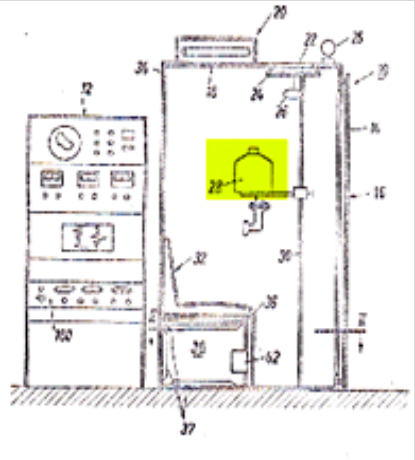
This type of cabin is easy to use and maintain.

Figure 2 shows the Volume cabin design, here the subject breathes from outside of the cabin and the Thoracic effort is measured by direct volume change from the sealed cabin. These had a wider sensitivity range than the constant volume design, however were slower in use, but of course an advantage was that the subject breathes room air and not the air contained in the closed cabin.

Figure 3 has the best of both worlds, it became known as the transmural cabin ("breath through the wall"). Again the subject is breathing from room air, in this design a large mesh opening acts as a direct pneumotachograph measuring the flow change generated by the thoracic movement, however as with any pneumotachograph the principle is pressure change over a resistance, therefore to correct the flow for any pressure generated the cabin also had a pressure transducer to provide feedback compensation to the box flow measurement. This design has the best sensitivity and wide frequency response.

Other concepts go right back to the original design; measurement of flow for airways resistance using low amplitude shallow panting, often described as "like a dog on a hot day". This was deliberate to "shunt" the flow back and forth in the dead space of the breathing head, without air leaving or entering the breathing head the flow was measured at BTPS condition without any further correction. Had the flow left the breathing head and then re-entered with ambient air the condition of expired and inspired would have changed.

In the original Erich Jaeger patent, he approached this problem differently and this was present on many production devices. The item highlighted and marked '28' (in the Figure below) was a BTPS bag, this contained a heater to maintain 37 degrees and a sponge that could be soaked in water, thus creating a body temperature, 100% Humidity environment which was directly coupled to the distal end of the Lilly Flow meter. This setup then enabled air to move through the flow head and valve, yet maintaining a BTPS condition. The enabled the use of what we know today as tidal breathing or quiet breathing airways resistance, and removed the need for panting.



This design persisted until the Jaeger company entered the USA market, whereon the FDA did not welcome the BTPS bag principle, highlighting it as a "breeding ground for bugs", the company went on then to invent the closed loop non-panting Airways resistance by mathematical models to replicate the BTPS bag situation, this approach is still used today.

For other providers the original panting at 1 to 2 Hz shallow breathing method is the common method.

CABIN Designs

As DuBois said in the opening comments (part 1, previous Inspire), the cabin is like a telephone box and this remains the most common construction. The housing should be rigid and resistant to airwave pressure swings, however the body Plethysmograph is a very sensitive manometer translating internal box pressures of typically less than 0.5 cmH_2O into volume equivalents, it remains a compromise between rigidity and sensitivity.

The USA company OHIO medical instruments were the first to venture to a new shape, this was known affectionately as the Ohio Egg and was usually bright blue in colour. Whilst this may seem a gimmick, the egg is one of the strongest shapes known to man and able to deflect pressure waves over its surface, this overcame a lot of the problems associated with ambient pressure swings.

The Morgan MkII Body plethysmograph followed this line using a lightweight design and what was often referred to as two bath tubs stuck together also used the EGG principle to deflect ambient pressure swings.

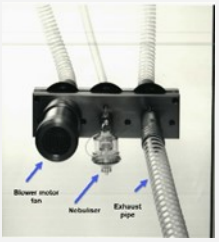
The curved designs remain today in the popular MGCD round design also some visitors to the ERS or similar medical congresses may have see the MEE version with two opening doors and a round design.

Despite differing designs, the applications remain unchanged although some other concepts have been explored, such as the Carefusion application for “mother and child” to comfort the child the mother enters the Cabin with the child on her lap, the combined body surface area is accounted for and during the measurement cycle the mother holds her breath at full inflation.

The original Morgan Mk1 cabin with its pneumatic door sealing clamps was used extensively by Glaxo in the Ware UK facility during the work and development of Histamine. For this application the front window was fitted with a blower circuit connected to an open two-way valve, the airflow then allowed room air to be drawn in and then returned to a vent port to be vented out of the room. The Histamine was projected towards the subject to inspire via a centre port on the two way valve body.

This worked to a degree, however when exacting doses were required Glaxo found the application of the Histamine was better controlled outside of the cabin and this then presented a further problem in that waiting time was required to achieve a stable cabin temperature in order to make measurements.

The research team at Glaxo struggled with this problem until the "obvious" solution was spotted, Warming the whole room to about 37 degrees means there is no temperature differential between the room to inside the cabin and measurements therefore could start directly. To compensate the high temperature staff were allowed to wear minimal clothing under their work overalls. **Ingenuity!**



The Body Plethysmograph remains a key part of Lung Function due to the speed of the lung volume determination and additional airways resistance measurements. The addition of a diffusion method with the cabin then provide the complete lung function instrument.

It is now common to find that the comprehensive range of test options include lung volumes by Helium Dilution or Nitrogen washout, this then allows the determination of the Total Lung Capacity (TLC) as represented by the ventilated area of the lung by gas dilution and also the Total Lung Capacity (TLC) measured by Plethysmographic methods that includes both ventilated and non-ventilated areas. The difference between the two can be an indication in chronic lung diseases of the gain that could be achieved by surgical intervention to remove damaged non-ventilated areas of the lung.

It can also be common to link the Body Plethysmograph to Bronchial Challenge test protocols allowing the effect of a Broncho-restrictor to be assessed by Flow Volume and the drop in FEV_1 obtained whilst also allowing the more sensitive measurement of Airways resistance to look for an increase in the resistance measurement.

To complete the Comprehensive Lung function testing, respiratory muscles can be measured by mouth pressures and Sniff pressure and neuro-muscular response can be assessed with P0.1 occlusion methods. In some parts of the world lung compliance is also measured with an oesophageal catheter.

For the single laboratory the Body Plethysmograph offers the most comprehensive range of measurements in a single device.

Finally:

Erich Jaeger summarised the History of the Body Plethysmograph in three phases, concluding in 1963 when the Body Plethysmograph had become in common Clinical use.

History of Bodyplethysmography by Erich Jaeger

On the history of whole bodyplethysmography 3 phases may be destined.

1.) Until 1953 all investigators recognized the possibility of evaluating the intra thoracic gas volume.
P. BERT , 1870 was probably the first who found out the difference between the volume displacement at the mouth and the simultaneous change in chest volume as caused by compression of intrathoracic gas.

2.) In the second phase, starting about 1953-54 scientists tried to mesure alveolar pressure in animal and man for purely scientifiques purposes, using P. Berts idea.

3.) Since 1963 the clinical use of bodyplethysmography in assessment of lung diseases has been common. Residual volume, total capacity and the measurement of alveolar pressure which may change tremendeously during diseases of lung and airways are the most important indicators.

It is therefore fitting tribute that the concept and design remain in use almost 60 years later in mainstream Lung Function measurements.

GOSH! - GREAT ORMOND STREET HOSPITAL LUNG FUNCTION LABORATORY GAINS IQIPS ACCREDITATION

MARTYN BUCKNALL (CHAIR OF THE ACCREDITATION CLINICAL ADVISORY GROUP (ACAG))

Congratulations to the team in the Respiratory Unit at Great Ormond Street Hospital (GOSH) who have become the latest service to be granted UKAS accreditation to the IQIPS standard in June 2021, and the first dedicated paediatric lung function service, demonstrating their compliance in meeting the IQIPS standard to demonstrate high quality care for their patients. IQIPS (or Improving Quality in Physiological Services) is an accreditation programme run by UKAS, and the standards have been developed and written by professional bodies within eight physiological science disciplines including respiratory and sleep physiology.

The Respiratory Unit has a suite of dedicated paediatric lung function laboratories to provide a range of diagnostic tests including spirometry, whole body plethysmography, gas transfer, exhaled and nasal nitric oxide (NO), multiple breath washout (MBW), exercise induced asthma, submaximal exercise, skin prick allergy testing, and hypoxic challenge tests on children of all ages. The service performs tests on over 4000 children per annum with a wide range of medical conditions including chronic lung disease, cystic fibrosis, lung transplantation, bone marrow transplants and rheumatology patients. They also provide a one-stop service to general respiratory, complex asthma, cystic fibrosis and neuromuscular clinics in the outpatient's department.

Martyn Bucknall (Chair of the Accreditation Clinical Advisory Group (ACAG)) caught up with **Emma Fettes** to discuss the journey to successfully gaining accreditation. Emma is the departmental lead for IQIPS, who led the process, which included working through the IQIPS standards to check compliance, liaising with the UKAS Assessment Manager, gathering and uploading all of the required evidence and leading the pre-inspection and formal inspection visits of the service.

ACCREDITATION IS NOT MANDATORY, SO WHY DID YOUR SERVICE DECIDE TO WORK TOWARDS IQIPS ACCREDITATION?

"I think it's vital ...to engage the whole lung function service in delivering IQIPS"

The physiologist team and our Lead Consultant all felt it was a valuable benchmark for evaluating our processes and important to demonstrate our commitment to quality improvement, it's been a real driver for focused service improvement. Following the strong endorsement from the Care Quality Commission (CQC) and NHS England & Improvement NHSE/I) for accreditation of diagnostic services, GOSH were keen to support accreditation status and appointed a Quality Lead (Vicki Heath) and are the first of the GOSH physiology services to go through the IQIPS process. Vicki was appointed to support IQIPS accreditation amongst many other roles, and comes from a pathology background, so is familiar with UKAS and the ISO pathology laboratory standards.

WHAT WERE THE 3 MAJOR BARRIERS IN APPLYING AND/OR WORKING THROUGH THE IQIPS PROCESS AND HOW DID YOUR SERVICE OVERCOME THESE?

1. Time/Workload – I suspect this would be top answer for many! Although there is a lot of work involved it helped having a physiologist lead on the quality management, with time set aside to do a lot of the evidence gathering and paperwork and to delegate jobs. The time spent preparing is so worthwhile and I am very proud of the dedication shown by the team to document how we met the standards and keep driving for improvements. Having support from Vicki (Quality Lead) helped motivate and keep to deadlines.

2. Like all Lung Function Laboratories, we had significant changes in how the service ran during the Covid-19 pandemic but we were still able to demonstrate how we had maintained quality and the systems in place to meet the IQIPS standards, even if these had changed during the pandemic e.g. the vetting of referrals, Infection Prevention Control (IPC) changes etc.

3. Due to the highly specialist nature of some of the services we provide, we had to consider how to provide evidence of ensuring quality and standards, this was helped with advice from our Quality Lead and discussions with other laboratories.

HOW IMPORTANT IS ENGAGING THE WHOLE LUNG FUNCTION SERVICE IN DELIVERING IQIPS?

I think it's vital, we were fortunate to have support throughout the Trust from the start and I think it helps the physiologists feel the process is valued and important. I'm sure I remember reading this as a previous answer in your interviews with other accredited services but I can echo it here - this requires an entire team effort and so involving all members of the team and giving individuals responsibilities or lead roles helps with engagement and ownership.

WHAT ADVICE WOULD YOU GIVE TO OTHER SERVICES WHO MIGHT BE THINKING ABOUT WORKING TOWARDS ACCREDITATION?

If you have funding, I found the pre-assessment helpful for checking my understanding of the standard requirements and confirm there were no significant gaps to address before progressing to formal assessment. Tap into all the experts within your Trust, I got in contact with so many different people for advice on Trust policy when reviewing our local SOPs and policies, and for gathering evidence for the IQIPS standards – everything from record retention to business case guidance to PALS.

I TALK TO MANY SERVICES WHO ARE KEEN ON ACCREDITATION, BUT DOWN TO TIME, WORKLOAD AND RESOURCE THIS SIMPLY IS NOT ACHIEVABLE – WHAT WOULD YOUR ADVICE BE TO THEM?

We spent a few years looking at the standards and knowing we were more or less there but it took a final push to review everything and take the leap to register for the assessment. Although there is an increase in workload there is so much which isn't time consuming as it is already documented e.g. calibration and Quality Assurance (QA) records. If the workload is too much with your current staffing consider whether you could apply for additional resources outlining the benefits of IQIPS accreditation, or whether a joined-up approach with other internal physiology services would reduce the workload.

DIFFICULT QUESTION, BUT IF YOU HAD TO ESTIMATE HOW MANY HOURS OF TIME WERE DEDICATED TO ACHIEVING ACCREDITATION, WHAT WOULD YOUR ESTIMATE BE? HOW LONG DID THE ENTIRE PROCESS TAKE?

This is really difficult as we spent a long time planning before eventually submitting and because so much of the work was a team effort. We first started looking at gap analysis in 2018 but in terms of gathering and uploading documents - from the formal application in October 2020 until our pre-assessment in December 2020 and then for the formal assessment in early March 2021, it took probably 2 days per week so > 200 hours.

HOW SUPPORTIVE WERE YOUR TRUST BOARD, MANAGERS AND CLINICIANS AND HOW DID THEY SUPPORT THE ACCREDITATION PROCESS?

The Trust were highly supportive of the process adding the project to the Trust Compliance Register. Our service manager attended meetings and provided KPI data, our clinicians were engaged with the process and gave input about service user surveys, referrals audits, results received, reporting etc. We are currently trying to agree funding for time associated with the ongoing work to maintain accreditation.

WHAT SERVICE IMPROVEMENTS OR CHANGES DID YOUR SERVICE MAKE DURING THE JOURNEY THROUGH ACCREDITATION? WERE THERE ANY QUICK WINS?

There were so many small but significant changes we made in our preparations, some examples were;

* Aidan Laverty (Service Manager) created a detailed 'SOP website' as an easy to navigate website interface for all the SOPs, risk assessments and associated paperwork for each test, as well as for quality and safety and audits.

* We expanded the scope of our audits to provide assurance in conformity to SOPs and policies. An example was auditing the time taken from receiving an order/ referral to vetting of the order to scheduling of the test.

* We introduced a focused patient survey for more department targeted feedback than the Friends and Family Test (FFT) and established links with the Young People's Forum (YPF) for more patient insight. The YPF is a group representing patients' and siblings' views, helping to improve the experiences of patients who are treated by GOSH. For example, a representative from the YPF was recruited to an interview panel for a paediatric respiratory physiologist.

* We introduced a Quality and Safety notice board which is updated daily with information for patients and visitors. The Quality and Safety Board is to support transparency for patients and we update this regularly. Examples of information include how we have acted on feedback, hand hygiene and bare below the elbow compliance. It also has a permanent section with staff pictures/roles and information on having a lung function test.

* The Trust moved to an EPR system in 2019 and we worked with their analysts and pharmacy to record each step of the bronchodilator testing order, prescription and administration process.

I would say quick wins are not re-inventing the wheel – use Trust policy where there is one, or find someone else in the Trust who is an expert in whatever standard you want to demonstrate. I was really helped by a couple of discussions with our accredited Radiology lead, it's not IQIPS but her experience with UKAS and particularly in patient experience seemed to really overlap.

The Team

(L-R): Mollie Riley, Emma Fettes, Carlota Roca-Mateo, Aidan Laverty, Claire Doughty, Kirstie Rodgers

Below: Stephanie Brotherston. Ben Griffiths

EARLY DAYS, BUT WHAT ARE THE BENEFITS TO DATE OF BEING AN IQIPS ACCREDITED LUNG FUNCTION SERVICE?

The benefits of going through the process and scrutinising the service in preparation has improved quality for patients and all service users. I think it will have a positive impact on recruitment, and I hope this will be the same with retention – there is definitely staff pride in the achievement, especially being the first accredited paediatric lung function laboratory. I think it's valuable for business cases and service development – the CQC and NHSE/I recognition means support is there.

"I would say quick wins are not re-inventing the wheel "

AND FINALLY, ARE THERE ANY OTHER POINTS YOU WISH TO RAISE OR COMMENTS TO ADD?

I think the process has been positive and raised quality. I would reassure anyone that the UKAS assessment managers were approachable and helpful. They were easy to contact with any questions or concerns and during the assessment itself the technical and lay assessors put the team at ease.

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Dr Harry Griffin (PhD)

Lead Respiratory Physiologist

Hampshire Hospitals NHS Foundation Trust

There has certainly been a shift on the forum away from COVID-related questions and the below highlights reflect this. However, I couldn't completely ignore COVID and thought I should include at least one discussion regarding fallow times. You may skip the first few if you would prefer non COVID-related discussions.

ARTP forum moved from Yahoo to Google in December and if you haven't already done so and wish to continue to send and receive emails from the ARTP Forum then you must complete the online form at the link below to confirm the contact details that you wish to be added. Consent Form Link - https://forms.gle/9bCAbMKSHE19gZbh7
The new email address for contacting the ARTP Forum is forum@artp.org.uk. Remember to add this email address to your safe senders list to ensure that you will receive emails from the ARTP Forum.

Top Forum

The best of the ARTP Forum

Title: Spirometry (During easing of lockdown)

Date: 19/05/2021

Question: How are services spacing spirometry appointment times out between patients or do you not have any gaps between patients given the new guidance? Have room air exchange rates affected any decisions?

Replies: The first reply from a member of the ARTP COVID-19 work force stated. "Despite the easing of lockdown, lung function remains an AGP-like activity..... please follow ARTP guidance..... 6 room air changes between patients removes ›90% of virus."

This possibly led to a little confusion with one physiologist asking if there was therefore no need to allow fallow time if they had 6 or more air changes/hour. A further, more detailed response from the ARTP COVID-19 member was provided and this was later supported by two other members of the group. They wrote "If you assume the patient is COVID+ve and that performing lung function is generating aerosols throughout their testing, then 6 air changes will clear 90% of any aerosols [in one hour]. This is done in the fallow period after the patient leaves the room". However, the Senior physiologist suggested a few factors which could help mitigate the COVID risks. These included: 1) Screening patients for symptoms (temp, fever, taste/smell, etc.), 2) Tested on the day using LFT or recent PCR, 3) Double vaccinated patients and staff, 4) Staff wearing appropriate PPE, 5) The amount of virus (i.e. cases/hospitalisations) in your local area, and finally 6) viral filter used and patient not coughing while off the mouthpiece.

Title: PFT's after COVID - how soon?

Date: 21/06/2021

Question: I'm sure this has come up on the forum during the first COVID wave but a lot has changed since then so a timely question by one of our leading paediatric physiologists. Is there "any guidance or specific evidence for performing PFT's on someone who has recently tested positive for COVID.....A quick look at the research shows the virus can potentially shed up to 16 days post a positive test so I would be erring on the side of caution and maybe wait 21 days."

Reply: Just the one reply which came from a member of ARTP COVID task force. They stated that if the staff member was in full PPE, the patient is breathing through a B/V filter and you vent the room & wipe down the contact parts of the kit, you could perform the tests immediately. However, they raised the question as to how useful reliable and clinically useful the results would be if they have a COVID cough.

Title: Resistances

Date: 26/05/2021

Question: Here we go, a non-COVID-19 question. "Does anyone know of some good papers on airways resistances pre and post bronchodilators including normal subject data and predictive values?"

Replies: The first reply came from one of our international colleagues who suggested a good read on airway resistance, that included Body plethysmography, IOS and FOT in the ERS Monograph from 2005: Lung Function Testing | European Respiratory Society (ersjournals.com). They suggested using "Specific Resistance" from body plethysmography, to compare pre and post bronchodilator because the "Resistance" is dependent on the FRCpleth level, which may change between pre and post. Finally, they highlighted that choice of specific resistance is important (sR_tot, sR_eff, sR_0.5, etc).

The physiologist who asked the initial question was grateful for this response and wrote that they were investigating whether there were more clinical uses of resistances as they didn't believe many physicians understood their use. Finally, they stated they liked using all the data from body plethysmography as they found resistances and FRC useful for monitoring for some dysfunctional breathers.

Title: Requesting by symptoms rather than tests

Date: 18/05/2021

Question: This physiologist discussed that they were looking to revamp the way that their tests were requested to a symptom/disease based system rather than requesting individual tests. They wanted to know if anyone already used this format and would be willing to share their experiences and how they structure their clinics.

Replies: This wasn't the only physiologist looking at changing how respiratory physiology tests were requested, with one physiologist stating they were investigating this approach but had identified lots of limitations and thus were only going to change the inpatient request form.

They reported looking into making this change because "lots of clinicians are being drafted in to see post-CV clinics and giving indication 'SOB' but not asking for gas transfer, and lots of 'COPD?' referrals with reversibility not ticked". In regard to the clinic structure they have 'standard' and 'long' slots with optional +15 minutes triggered if supine VC or communication difficulties/movement difficulties are ticked. Furthermore, they had added 'vulnerable- first in list' and 'cough- last in list' categories too, although this extra workload hadn't gone down well with the admin team.

A Senior physiologist described how in their department Senior scientists screen all requests and add extra tests to help answer the clinical question. However, they highlighted the issue around bronchodilator response, as a respiratory & sleep Scientist can only work within the confines of a Patient Specific Direction. This requires the requesting clinician to state the drug, dose and delivery method on the request and that it is not possible to modify the medication. This may be resolved soon if legislation is passed that allows Clinical Scientists to work within the Patient Group Directions framework.

Another physiologist described an approach whereby they offered internal referrers different 'test sets' based on diagnosis but still allowed the referrers to select tests themselves or add to the sets. They felt it had worked well for several years and specifically helped standardise the tests performed for different patient groups (e.g. post lung transplant, annual review etc).

Another approach used by a different service was to provide a handbook on the hospital IT system that explains the various tests, how long they take, the average waiting time for test etc. It also included a section advising clinicians which tests to request if they were suspecting a specific condition (e.g. COPD, asthma, ILD) or if they were just investigating symptoms (cough, breathlessness etc). In regards to reversibility testing they would email the clinician asking if they would like them to administer a bronchodilator and then keep the email reply as evidence.

Top Forum

Title: CPEX essential requirements

Date: 11/06/2021

Question: The physiologist asked the forum for some advice regarding what ARTP and/or CPEX services recommend as essential requirements for physiologist-led CPEX sessions. Specifically, they asked whether it was essential for both physiologists to have ILS qualifications or just one CP? And secondly whether both physiologists need to be competent in ECG interpretation or just one CP?

Replies: A CPET service lead who regularly helps respond to CPET questions on the forum was happy to respond. They stated "The POETTS society* guidance discusses staffing requirements for a CPET/CPEX laboratory. They also referenced the American Heart Association's recommendations for clinical exercise laboratories. Both state that during a CPET/CPEX, there should be at least two members of staff. Additionally, the lead should be trained in resuscitation and able to identify abnormal responses to exercise. In answer to your question, it would therefore be essential for only one member to have ILS training and be competent in ECG interpretation."

In contrast to the AHA's view that a clinician should lead the service, the UK based "POETTS take the view that a CPET service can be physiologist-led, but suitably trained medics should be involved in the translation of the physiological data to preoperative risk – which seems reasonable."

*POETTS-Perioperative Exercise Testing & Training Society (https://www.poetts.co.uk/)

Title: GLI TLCO reference values correction

Date: 22/06/2021

Question: The physiologist had recently come across the correction to the GLI TLCO reference values particularly with respect to females with low TLCO values having exceptionally low z-scores https://erj.ersjournals.com/content/56/4/1750010. They wished to know what other labs had done to address this. The physiologist posted this link to gather the thoughts of the forum members. https://forms.office.com/r/6wuss6pH4Y and hoped to present the findings as an abstract looking into UK prevalence of GLI implementation and the main barriers to implementing it.

Replies: A Co-author of the original GLI reference values and currently a Co-Chair of GLI Executive Committee expressed their gratitude for raising this issue amongst the ARTP community and highlighted that the GLI Executive Committees were trying to share this update around the world.

Title: CPET masks

Date: 23/06/2021

Question: The physiologist asked "Are there any published or non-published studies comparing VO_2 peak using a Hans Rudolph mask with that obtained using a neoprene mask?

Replies: The first response came from our regularly helpful CPET service lead who stated they had performed biological QCs using both masks. At low levels of exertion it did not really have an impact but at high intensity there were changes to VO_2, V_E and VCO_2 that he felt were probably explained by a leak.

A Senior physiologist then asked the follow up question "In fitted masks without any leak is there any difference in the VO_2 obtained at peak? ". In response, an ARTP life member and CPET expert provided a detailed response but I'd advise you to grab a coffee and put your CPET hat on before reading this. "Unlike using a mouthpiece the face mask is like a reservoir and whilst there can be minimal gas mixing in the mask at high ventilation this is unlikely a cause. However, with

perspiration and exhaled water vapour accumulating in the mask, [this] may off set the partial pressures of the absolute gas readings..... So you could have minimal volume loss due to water vapour "raining out" in the mask dead space and reduction is measured gases due to increase water vapour in the sample line and the effectiveness of Nafion tubing. I suspect undetectable in terms of PEAK performance. Any "difference" is more likely to be the data averaging method and how outlying breath data is dealt with". Everyone understand that right? good ☺.

Title: Reversibility

Date: 29/06/2021

Question: This physiologist was having problems with how to deliver a reversibility service. "PGD - as a Non HCPC registered physiologist, I am informed that I can't work to this. PSD - fine, but each patient will need Salbutamol and spacer prescribed by prescriber prior to the appointment. Under this, I am unable to keep a local stock of Salbutamol for when patients fail to bring the MDI and spacer".

Replies:

A reply from a senior ARTP board member stated that even HCPC-registered staff cannot legally work within a PGD. However, you can work within a PSD where the requesting clinician with prescribing rights who reviewed the patients indicates on the referral the drug, dose and delivery method. We keep a stock of salbutamol MDI's in a locked medicines cabinet. The drugs are stored in accordance with pharmacy policy with sign-in and sign-out sheets and only administered by staff who have completed their drugs administration competency training and are in date for peer review.

Another physiologist stated that they use 2.5mg salbutamol via nebuliser which gets around the problem of having to keep a stock of MDIs. Drugs get signed in and out of the drugs book for good record keeping and this has all been signed off by the lead pharmacist. A copy of the PSD is scanned onto the patient record along with the PFT result. The PSD needs a physical signature from the doctor but once our new EPR happens next year we will be able to accept an electronic PSD which makes life easier.

Title: Spirometry via Full face mask.

Date: 30/06/2021

Question: This physiologist reported receiving a request for a patient who has had a previous Cranio-Facial resection. Spirometry and CPET were previously attempted, but an adequate seal was not possible with either flanged or tube mouthpiece and CPET mask. Could spirometry be performed via a full face mask? Could the large dead space have a significant impact on measurements?

Replies:

A previous chair of ARTP discussed the potential for structured light plethysmography (SLP) in producing a flow-volume curve from just the chest wall movement. Furthermore, they stated that deadspace only really matters for gas analysis and thus for CPET it is required in all calculations of VO_2, VCO_2 and their derivatives. They described the easiest way to measure the deadspace is to put a bung in the outlet tube and block off any leaks and fill it to the brim with water from a measuring cylinder.

In reply to this comment one of our international colleagues confirmed this is the best approach to measure dead space. However, for the correction calculations in CPET the physiologist believes this approach overestimates deadspace as not all the deadspace is ventilated, especially at high ventilatory rates. Indeed, they have previously used ca. 85% of the dead space but felt that 40-50 % might be more appropriate.

In regard to using a face mask for spirometry, one physiologist stated they used anaesthetic masks with the pneumatic cushion that fitted well to various B/V filters. They reported very little deadspace for performing spiro, transfer factor, static volumes and muscle function with little difference compared to mouthpieces. Another physiologist also confirmed that they could perform spirometry using an anaesthetic mask attached to B/V filter.

Dr Harry Griffin (PhD)

Lead Respiratory Physiologist

Hampshire Hospitals NHS Foundation Trust

Top Forum

Title: Survey invitation (pre and post COVID-19 BioQC)

Date: 02/07/2021

Question: Following on from discussions at the ARTP conference, this physiologist was planning a study examining lung function pre- and post-COVID-19 in biological controls. The physiologist specifically wanted to examine potential changes in FRC/TLC where no TLco change was observed but wanted to collaborate with anyone who had their own questions. They asked physiologists to complete the attached survey https://form.jotform.com/211824461058352

Replies: A member of the ARTP COVID-19 Group highlighted that the Group had already written a full proposal and developed a method of on-line data collection through ARTP Admin. They were just awaiting ethical approval, which another member of the group subsequently confirmed would be actioned soon. However, they also stated it would make sense to look at the initial physiologist ideas and see if they can combine the projects.

Title: Fitness to Fly

Date: 13/07/2021

Question: With air travel beginning to resume post-COVID this physiologist reported receiving requests for hypoxic challenge tests (fitness to fly). They previously reported performing these prior to COVID on the NHS and wanted to know what other departments were doing.

Replies: One physiologist stated they performed them on the NHS but were aware others now only do it privately. A second reply from a senior member of ARTP also stated they performed them on the NHS but highlighted that even if departments performed them privately that the department/staff might not see the money.

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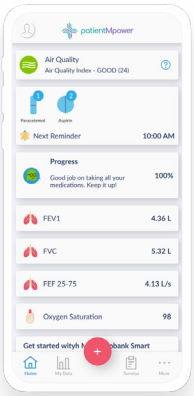

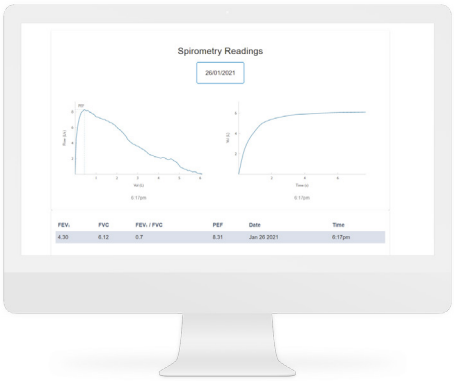

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West Midlands
Northern Ireland
East of England
East Midlands

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

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

For more information, please contact the ARTP Network Co-ordinator, Geraldine O'Connell-Ramsay, at **networkcoord@artp.org.uk**

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1st-2nd July 2021
ARTP Association for Respiratory Technology & Physiology

Thursday 1st July 2021

0800 — Manufacturer's Exhibition and Networking

0830-0900 — Industry Workshop Sessions

Fisher and Paykel Healthcare	*Intermedical*	*NuvoAir*	*ResMed*	*Vitalograph*
An update from F & P; what's new and where next?	*How to improve indoor air quality with portable air purifiers*	*NuvoAir Home: Self-monitoring of lung health for people with respiratory conditions*	*Digital pathways for Sleep and Respiratory Care during COVID and beyond*	*Implementation of the ATS/ERS Standardization of Spirometry 2019 Update*

0902-0917 — Welcome and Introduction Day 1
ARTP Chair: Julie Lloyd

0919-1019

Fundamentals of Gas Transfer Chair: Emma Ince		Introducing Diagnostic Hubs into Service Delivery Chair: Julie Lloyd		Diagnosing Paediatric Patients at Home Chair: Phillip Lawrence	
0919-1009	**Richard Glover** *Basic Principles and Clinical Interpretation of Gas Transfer*	0919-0929	**Sara McArthur** *An Overview of Respiratory and Sleep Science in Scotland*	0919-0944	**Paul Burns** *Home Spirometry in Paediatric Patients*
		0929-0939	**Prof. Brendan Cooper** *An Overview of Respiratory and Sleep Science in England*	0944-1009	**Emily Senior** *Home Sleep Studies in Paediatric Patients*
1009-1019	Q&A	0939-0949	**Alex Perkins** *An Overview of Respiratory and Sleep Science in Wales*		
		0949-0959	**Lisa McManus** *An Overview of Respiratory and Sleep Science in Northern Ireland*		
		0959-1019	Facilitated Discussion	1009-1019	Q&A

1021-1056 — P K Morgan Memorial Lecture
Chair: Julie Lloyd
Prof. Bruce Thomson
Can you actually image how the lung is functioning?

1056-1106 — Q&A

1106-1123 — Break, Manufacturer's Exhibition and Networking

1123-1253 — Poster Presentations – Respiratory
Chair: Sam Irving

1255-1325 — Lunch, Manufacturer's Exhibition and Networking | Industry Drop in Chat

1327-1402 — Covid-19 Session
Chair: Jo Shakespeare
Prof. Stefano Nava
Covid-19: a personal journey

1402-1412 — Q&A

1414-1514

COVID-19 in Children Chair: Emma Fettes		Global Lung Initiative Chair: Ian Cliff	
1414-1439	**Prof. Calum Semple** *The ISARIC WHO Clinical Characterisation Protocol*	1414-1439	**Dr Sanja Stanojevic** *The Challenges of Interpreting PFT/Uncertainty of Interpretation*
1439-1504	**Dr Rossa Brugha** *The Treatment and Follow-up of Paediatric Multi-system Inflammatory Syndrome Temporally Associated with Covid-19 (PIMS-TS)*	1439-1509	**Dr Graham Hall** *GLI – The Future*
1504-1514	Q&A	1509-1514	Q&A

1516-1601 — Extreme Physiology Session
Chair: Dr Karl Sylvester
Prof. Chris Imray
Consultant Vascular and Renal Transplant Surgeon & Director of Research and Development, UHCW NHS Trust
The Physiological Impact of Polar Environments

1601-1616 — Q&A

1618-1718 — Oral Presentations
Chair: Dr James Stockley

1618-1633	**Jodie Hunt** *Development of a Telephone Consultation Triage System for Urgent Home Visit for Long Term Oxygen Therapy (LTOT) Patients During the COVID-19 Pandemic*
1633-1648	**Natalie Wilson** *The implications of adopting the Global Lung Function Initiative (GLI) equations in an adult non-caucasian patient population in Berkshire.*
1648-1703	**Deirdre Blissett** *Potential health economic impact of untreated mild OSA compared to treatment with eXciteOSA*
1703-1718	**Rebecca Griffiths** *The evolving role of the Respiratory Physiologist in managing patients with stable ILD*

1720-1800 — What Have we Learned About Covid-19?
Chair: Max Thomas

1720-1732	**Dr James Stockley** *Physiology of Covid-19*
1732-1744	**Dr Nandan Gautam** *Treatments for Covid-19*
1744-1800	*Q & A*

1800 — Conference Day 1 Close

Friday 2nd July 2021								
0800	Manufacturer's Exhibition and Networking							
0830-0900	Industry Workshop Sessions							
	Circassia *The Importance of FeNO in Asthma*		***Jazz Pharmaceuticals*** *Excessive Daytime Sleepiness (EDS) in drivers with obstructive sleep apnoea: A patient-centred physiologist-led conversation*		***SomnoMed*** *Tools to build a business case for Oral Appliance Therapy in the treatment of OSA*		***Vyaire Medical*** *Introduction to Tidal Breathing Analysis Using Impulse Oscillometry*	
0902-0917	**Welcome and Introduction Day 2** **ARTP Chair: Julie Lloyd**							
0919-1019	**Back to the Fundamentals of Physiology** **Chair: Dr Vicky Cooper and Jordan Ulmer**		**Back to the Fundamentals of Physiology** **Chair: Kelly Pauley**		**Cardiopulmonary Exercise Testing** **Chair: Karl Sylvester**		**Interventional Pulmonology** **Chair: Dr Vicky Moore**	
	0919-1009	**Laura Jess** *Obstructive Sleep Apnoea and Pulse Oximetry Clinical Cases*	0919-1009	**Shirley Coelho** *Lung Volumes: physiology and clinical cases*	0919-0944	**Prof. Susan Ward** *Cardiovascular and Ventilatory Response to Exercise*	0919-0949	**Dr Ravi Mahadeva** *Lung Volume Reduction Surgery* *Endobronchial Valves*
	1009-1019	Q&A	1009-1019	Q&A	0944-1009	**Dr Luke Howard** *Cardiopulmonary Exercise Clinical Cases*	0949-1004	**Dr Mohamed Al-Aloul** *Lung Transplant*
					1009-1019	Q&A	1004-1019	Q&A
1021-1106	**Sleep Keynote Session** **Chair: Dr Sara Parsons** **Speaker: Dr Michelle Ramsay** *Adaptations to NIV in the Acute Setting*							
1121-1136	**Break, Manufacturer's Exhibition and Networking**							
1138-1308	**Poster Presentations - Sleep**							
1308-1400	**Lunch, Manufacturer's Exhibition and Networking**				**Industry Drop in Chat**			
1400-1425	**Chair: James Hull** **Dr Leigh Seccombe** **Principal Scientist and Clinical Associate Professor at Sydney Medical School** *Measurement of Dead Space and Blood Gases*							
1427-1457	**Annual General Meeting**							
1459-1629	**Technological Advances in Sleep** **Chair: Mike Lang**		**Where is Lung Function Going: a global view?** **Chair: Sara McArthur**		**How is Innovation Going to Change Lung Function?** **Chair: Laura Jess**			
	1459-1524	**Dr Jean-Louis Pépin, University of Grenoble** *Assessment of Mandibular Movement Monitoring with Machine Learning Analysis for the Diagnosis of OSA*	1459-1524	**Prof. Bruce Thompson** *An Australian View*	1459 - 1600	**Dr Chris Carlin** *Artificial Intelligence and Respiratory Physiology*		
	1524-1549	**Prof. Dr Thomas Penzel, Scientific Chair of Sleep Center, Physicist,** *New Technology to Assess Sleep Apnoea: wearables, smartphones and accessories*	1524-1549	**Dr David Kaminsky** *AARC/ATS View*				
	1549-1614	**Prof. Dina Katabi,** *Monitoring Sleep with Radio Waves*	1549-1614	**Prof. Brendan Cooper** *Healthcare Science Overview*				
	1614-1629	Q&A	1614-1629	Q&A				
1631-1716	**Extreme Physiology Session** **Chair: Dr James Hull** **Prof. Jeroen Swart** *Testing the Greats: lessons from CPET testing elite athletes*							
1718-1733	**Closing Remarks** **ARTP Chair: Julie Lloyd**							
1733	**Conference Close**							

Edited by

Dr. James Stockley

ARTP Research & Innovation Chair

FRESH AIR

Dear Reader,

*Welcome once again to **'Fresh Air'**. This section is designed to communicate novel trends in research, innovation and clinical practice from both respiratory and sleep sciences. Our goal is to share new ideas within the ARTP community in the hope of driving the evolution of physiological practice.*

In the wake of an excellent virtual ARTP Annual Conference, we present the collected abstracts that were presented during the poster and oral sessions. Understandably, many abstracts focused on quality improvement, detailing innovative ways in which departments have adapted their practice in response to COVID-19 restrictions but it was fantastic to see that members have also been able to conduct other research in challenging times. We were delighted to see so many submissions and I would like to extend a huge thank you to everyone who presented their research at the Conference.

Thursday 1st July 2021

Poster Presentations—Respiratory

Chair: Sam Irving

Friday 2nd July 2021

Poster Presentations—Sleep

Chair: Dr James Stockley

Thoraco-abdominal aneurysm case study and the multi-disciplinary approach to assessment and treatment.

Miss Julie Brown

NHS Lothian (RIE, Edinburgh), Edinburgh, Scotland

Introduction

Smoking, high blood pressure and atherosclerosis increase the risk of developing abdominal aortic aneurysms (AAA). Most are asymptomatic and common in men over 65 years old. Prevalence is estimated at 1.3-8.9% in men and 1.0-2.2% in women.[1]

Case Presentation

I present a case study of a male aged 65 years who attended our Respiratory Physiology Department for pre-operative assessments. Past medical history includes ex-smoker, coronary heart disease, hypertension. Family history revealed stroke and heart problems. Surgery in September 2020 on ascending aorta, total arch replacement and frozen elephant trunk. Post-operative complications included hospital acquired pneumonia but made a good recovery. Patient was subsequently diagnosed with a 6cm Extent II thoraco-abdominal aneurysm (TAAA) following initial surgery.[2]

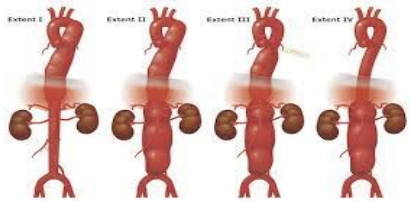

Figure 1. Classifications of TAAA (m.ufhealth.org)

Pre-Operative Assessment (TAAA)

Cardio-Pulmonary Exercise Test:

Protocol 15 Watts/minute ramp; Time – 11 minutes. Stopped due to leg discomfort; VO_2 Peak 16.9 (millilitres per minute per kilogram) 74% predicted; Anaerobic Threshold 12.2 (millilitres per minute per kilogram); Blood pressure response appropriate for rise during exercise. O_2 pulse normal. Normal ECG.

Pulmonary Function Tests: Mildly Obstructive Defect FEV_1 2.44 (72% predicted), FVC 4.03 (91% predicted). Pre-operative testing as an intervention improves a patient's recovery after surgery and a means of predicting both 30-day outcome and 30-month mortality.[2]

Outcome/Multi-Disciplinary Approach (MDA)

Patient has been deemed fit enough for second stage surgery on a TAAA following MDA discussions. MDA provides a diverse perspective along with test results to maximize the patient journey, assess long term needs and after care. [3]

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Comparison of different interfaces for multiple breath inert gas washout technique

Miss Hina Mir, Ms Rasheda Choudhury, Dr Caroline Pao

[1]Royal London Hospital Children's Hospital, Children's Respiratory and Sleep Physiology Team,

Background: Lung Clearance Index (LCI) is a marker of lung ventilation inhomogeneity and is measured using multi-breath washout techniques (MBW). MBW measurement can be performed with numerous interfaces including; mouthpieces, masks and mouth guards. Different interfaces can increase the equipment dead space, and inaccurately increase parameters of the MBW test. Lum et al (2015) found that LCI tested with masks had increased LCI versus mouthpiece usage, therefore using masks exceeded normal within test variability and could influence interpretation of results.

Objective: We examined the effect of interface; Mouthpiece and nose clip (A), Mouth guard and nose clip (B), and Mask (C) on functional residual capacity (FRC) and lung clearance index (LCI 2.5).

A  B  C 

Methods: This case study incorporated repeated measures and interface comparison in one healthy adult. The Nitrogen MBW measurements were performed on Eco Medics AG Exhalyzer D on set 3 and under standard conditions. During the MBW test the subject maintained a leak-free seal while tidal breathing through equipment to measure inspired and expired volumes and gas concentrations. The breathing pattern on all tests were stable without any leaks and extreme changes in volume or flow. ERS/ATS guidelines stipulate 5% repeatability within three technically acceptable tests.

Results:

MBW Parameter	Mouthpiece	Mouth Guard	Mask
LCI 2.5	7.86	7.19	7.21
FRC	2.40	2.47	2.17
RQ	0.85	0.98	1.07
VT mean/FRC	0.313	0.316	0.365
VdCO2	136	125	129

FRC = functional residual capacity; LCI 2.5% norm = normalised lung clearance Index at 2.5%; RQ= respiratory quotient; VT = tidal volume; $VdCO_2$ = volume of gas coming from dead space

RQ is assumed to equate to respiratory exchange ratio at rest and is calculated as volume of CO_2 expired /volume of O_2 consumed. Normal RQ range is between 0.8 – 1.0, and represents stable breathing. Abnormal RQ can be due to hyper/hypoventilating or presence of a leak. All interfaces RQ remained within 0.9-1.1, which suggest the absence of any leak or unstable breathing.

Mouthpiece vs Mouth guard – LCI 2.5 values were within 9.3%. Our between tests FRC was within 2.9% of each other. Mouth guard vs Mask – LCI 2.5 values were within 0.3%. Our between tests FRC was within 13.8% of each other.

Mask vs Mouthpiece – LCI 2.5 values were within 9.0%. Our between tests FRC was within 10.5% of each other.

CONCLUSION:

According to this case study the most repeatable MBWs were performed on mask and mouth guard interface, the difference between the LCI 2.5 results was 0.3%.The largest inter-test LCI difference was observed between Mouthpiece and Mouthguard, followed by Mouthpiece and Mask. These larger differences may be due to the difficulty to maintain a good seal with the mouthpiece. All FRC interface results were repeatable within 14% of each other. In order to verify our findings a larger sample size would be needed.

Do bacterial/viral filters impact quality assurance verification of ultrasonic spirometers

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Background: Spirettes on ultrasonic spirometers (Easy on-PC, Intermedical UK) protect the device from cross infection. Adding a bacterial/viral filter (BVF) may further protect healthcare professionals, but the impact on measurements has not been fully established.

Aims: To determine whether accurate volume verification (± 3% of 3 litres) was achieved with the addition of two commonly used BVF applied to the ultrasonic spirometer.

Method: Verification was performed with the addition of each BVF on either the proximal or distal end of the ultrasonic spirometer using a 3 litre syringe at low (0-2 L/S) medium (2-8 L/) and high (8-12 L/S) flow rates and was repeated 10 times on 3 separate days. Values were averaged to establish verification achievement.

Results: Verification results for expiratory volume and inspiratory volume are shown in Table 1. For both different BVF placed proximally, expiratory volume verification was achieved only at middle and high flow rates, while inspiratory volume verification was achieved at all flow rates. For both different BVF placed distally, expiratory volume verification was achieved at all flow rates, but inspiratory volume verification was not achieved at any flow rates.

	Low flow rate		**Middle flow rate**		**High flow rate**	
	EV	IV	EV	IV	EV	IV
No BVF	2.94 ± 0.02	2.92 ± 0.03	2.99 ± 0.03	2.97 ± 0.03	2.98 ± 0.04	2.96 ± 0.02
BVF distal (Vitalograph)	2.91 ± 0.04	2.90 ± 0.02	2.99 ± 0.02	2.83 ± 0.04	2.97 ± 0.03	2.83 ± 0.04
BVF proximal (Vitalograph)	2.88 ± 0.03	2.91 ± 0.02	2.97 ± 0.03	2.95 ± 0.03	2.97 ± 0.03	2.96 ± 0.02
BVF distal (Vyaire)	2.93 ± 0.04	2.86 ± 0.05	3.00 ± 0.04	2.88 ± 0.02	2.99 ± 0.02	2.88 ± 0.02
BVF proximal (Vyaire)	2.80 ± 0.04	2.92 ± 0.03	2.96 ± 0.02	2.96 ± 0.03	2.93 ± 0.02	2.95 ± 0.02

Table 1: Results of the verifications performed with the different bacterial/viral filters

Values are presented as mean volumes in litres with standard deviation. Values highlighted in bold did not meet the verification calibration acceptability criteria. BVF= bacterial viral filter. EV= expiratory volume IV= inspiratory volume

Conclusion: Placement of either BVF proximally, which is the usual site of BVF placement, impacted verification of expiratory volumes at low flow rates. With either BVF placed distally only inspiratory volume verification was impacted. If application of BVF is required to reduce the risk of cross infection, the recommendation would be to place the BVF distally, but only if inspiratory volumes are not of clinical importance.

Outcomes from a tertiary level home oxygen service during the COVID-19 pandemic

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Introduction: Coventry and Rugby Home Oxygen Service (HOS-AR) serves ~466,500 people. Currently 458 patients are prescribed home oxygen. Patient assessment takes place face-to-face in outpatient clinics or at home. In response to COVID-19 HOS-AR adapted service provision to meet the changed needs of our patients by adopting remote access care. We present results from our first dataset.

Methods: We compared data from 2019/20 and 2020/21. HOS-AR referrals and HOOFs for both acute and outpatient services were reviewed. We reviewed data from virtual consultations between June and August 2020.

Results: Compared to 2019/20, 70 (25%) fewer home visits were performed. Overall, 70 (8%) more HOOFs were submitted but 45 (21%) fewer were for new patients. Fewer new HOOFs were placed for long term (38; 36%) and ambulatory (15; 29%) oxygen, but more were placed for palliative oxygen (18; 46%). 21 (11%) more inpatient oxygen referrals were received, with 26 (19%) more patients discharged with oxygen. 28 inpatient HOOFs (17%) were for patients recovering from COVID-19.

160 virtual consultations were performed; 97% of patients answered the phone. Average call time was 12 minutes. 49% patients had access to pulse oximetry. 11% of patients required a further face-to-face review due to a changed clinical condition.

Conclusion: In response to COVID-19 and to ensure continuity of care HOS-AR restructured service provision to utilise available resources more efficiently including staffing and facilities whilst maintaining safe and effective care. Working in partnership with acute services we responded to increased inpatient activity facilitating patient flow, supporting patient discharges and bed capacity.

COVID-19 has promoted telemedicine; nearly half of patients had access to pulse oximetry during virtual consultations. This suggests that elements of remote care could be feasible in HOS-AR, but more data is required to assess safety and clinical effectiveness.

Predicting the implications of COVID19 on lung function waiting lists across Wales

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Surveys appear limited in their ability to predict the future impact of COVID 19 on waiting list (WL) numbers. If future WL numbers could be accurately estimated proactive plans could be put in place. Following information on capacity/demand requested via the Welsh Scientific Advisory Committee (WSAC), a model was developed which attempts to predict lung function WL data; considering the reduced capacity due to COVID19.

An Excel Spreadsheet was created, this uses the forecast function to predict the future monthly WL numbers, based on the previous two years of data. The user estimates average number of tests performed for the test of interest (i.e., PFTS/Spirometry), on an average week prior to and during COVID19. Using this method, the model attempts to forecast monthly WL numbers based on historical data, utilising pre- and post-COVID capacity, with upper and lower confidence limits.

This predictive model was disseminated to respiratory colleagues on the WSAC subgroup and the chair of ARTP Wales and is still open to contributors. The first five contributors are presented in this exercise, in an attempt to verify how closely the predictive model fitted each hospital WL number for February 2021. This was achieved utilising the data submitted in October/November 2020. Each contributor will also attempt to include an explanation of any observed differences. A summary is presented in table 1 below.

The findings are due to be assessed via Microsoft Teams. This allows direct capture of the actual WL numbers and for each contributor to then formulate a paragraph for submission related to their service to integrate into the overall submission in the format required for the ARTP conference.

Data collated in the WL prediction model via this multicentre collaboration will also be used to inform discussions within the ARTP Wales committee. The outcomes will be fed back via the WSAC subgroup, providing WSAC with objective information on the impact COVID 19 has had on respiratory physiology services, how these services have adapted to the challenges posed by COVID 19 and highlighting any unmet needs that remain.

Hospital	Est. reduced capacity %	Pred WL change in Feb 21(%) (95% confidence limit)	Actual % change in WL Feb 21 to Feb 2020	Within prediction
Wrexham Maelor	83	318 to 366	217	Lower
Ysbyty Gwynedd	**61**	**131 to 294**	**271**	**within**
Llandough	**46**	**146 to 261**	**185**	**within**
Singleton	47	155 to 221	89	Lower
Morrison	67	284 to 423	184	Lower

Overcoming the challenges of Covid-19 waiting lists: Drive through Spirometry, a service evaluation

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Background: The Respiratory Investigations department at North West Anglia NHS Foundation Trust consists of two main testing sites, Peterborough City Hospital and Hinchingbrooke Hospital. Pre-Covid activity levels within the Respiratory Investigations Department cross site saw on average 150 patients per week. During the Covid-19 pandemic activity reduced to levels as low as 25%. Furthermore, at Peterborough City Hospital, 10% of offered appointments resulted in failure to attend or cancellations due to patient concerns of the potential risk of catching Covid-19 within a hospital environment. The result of which saw a significant increase in waiting list times. In an attempt to keep services running, reduce patient anxiety and reduce waiting list times, a drive through lung function service was developed.

Service overview and benefits: The outdoor drive through lung function service was developed to provide spirometry, Fractional Exhaled Nitric Oxide (FENO), overnight pulse oximetry collection and return, safely in the patient's car. The service was open to both primary and secondary care providers. Patients would not need to enter the hospital at all, herby reducing footfall, reducing patient anxiety and allowing more tests outside per session compared to lab-based testing.

Aim: To evaluate and improve patients experience of a drive through lung function service.

Method: An online survey was created through survey monkey consisting of 10 questions, 2 of which allowed the patient to write their own comments. The link for this would be sent to all of the patients who have visited the drive through and have the ability for texts to be sent from the hospital. The preliminary data was reviewed monthly so the patient feedback could be reviewed and acted upon accordingly.

Results: Of the 298 patients tested at our drive through service cross site, 243 of the patients gave permission to be contacted for a service evaluation survey. 116 of our patients completed the survey. 62.93% of these patients felt the contact prior to their appointment was excellent.
50.86% of these patients felt the instructions and signage was excellent. 78.44% of these patients felt they knew what they were expecting prior to their appointment. 98.27% of these patients felt the appropriate infection controlee measures were in place.100% of these patients felt safe during the test. 97.41% of these patients said that their member of staff who tested them introduced themselves. 79.31% of these patients would prefer this service compared to hospital-based testing.
96.55% of these patients would recommend this service to their friends and family. Waiting list times reduced from a three month wait to within the target six week wait for diagnostics.

Conclusion: The drive through lung function service is a positively evaluated service and an effective way of reducing patient anxiety and reducing waiting list times during the Covid-19 pandemic.

How COVID 19 impacted Lung Function Testing at Royal London Hospital

Miss Hina Mir, Ms Rasheda Choudhury, Dr Caroline Pao

Royal London Hospital Children's Hospital, Children's Respiratory and Sleep Physiology Team

Background

Pulmonary function testing has become an integral tool in the diagnosis, management, assessment and follow-up of patients with respiratory conditions. This audit was performed to examine the impact of COVID 19 on lung function testing frequency. Lung function testing could represent a potential avenue for COVID 19 transmission because of the potential for coughing and droplet formation surrounding spirometry manoeuvres.

Method

We analysed our Excel database from the 1st of January 2020 until the 31st of December 2020, over this time we tested a total of 816 patients. This is a large contrast to 1st of April 2019 until the 31st of March 2020, over this time we tested 1626 patients.

Month	JAN	FEB	M	A	M	J	J	A	S	O	N	D	Total
Patients	154	139	67	11	18	41	49	54	77	93	88	79	816

Results

As you can see from the table there was a significant decline in testing in March. This was due to the first lockdown in March 2020; we limited lung function testing to patients deemed essential for immediate treatment decisions, and protective measures to protect staff and patients including personal protective equipment (PPE) that limits aerosolised droplet acquisition for staff plus enhanced cleaning of the testing space was implemented e.g. wiping down surfaces with appropriate cleaners.

As spirometry is considered an AGP, we had to take laboratory air changes in to account when booking outpatients; 40 minutes was required after each patient to recycle the clean air back into the room. Pre-covid we would be seeing 12 patients in an afternoon clinic for lung function, this was limited to 4 during covid.

To manage our patient's care and review patient's lung function, we purchased >50 home spirometers from NuvoAir to monitor our shielding patients. 74% of independent tests achieved the ATS/ERS 2005 repeatability criteria for FEV_1. The machines allowed our patients to feel connected and supported while at home. We found this new service to be successful, producing adequate results and have been utilising them during virtual clinics as this reduced face to face exposure during COVID-19. We are aiming to order another 30 spirometers to expand the spirometry service.

Conclusion

We expected a reduced number of lung function testing during this period as a significant number of our patients were shielding at home, and the majority of face to face clinics are now telephone consultations.

Running a paediatric diagnostic service in a pandemic and beyond

Dr Jo-anne Johnson[1,2]

[1]*Anglia Ruskin University School of Medicine, Chelmsford, UK,* [2]*East Suffolk And North Essex Foundation Trust, Colchester, UK*

Problem:

The WHO declared the COVID-19 global pandemic a public emergency on 20th January 2020.[1] The UK went into lockdown on 16th March 2020 with a suspension of elective services in hospital trusts.[2]

Our ambulatory paediatric sleep-disordered breathing service set in a district general hospital performs level 3 cardiopulmonary studies on patients with suspected obstructive sleep apnoea (OSA) secondary to adenotonsillar hypertrophy, obesity or more complex issues pre-disposing them to OSA (e.g. craniofacial abnormalities, neuromuscular disease or Down's syndrome).

Resuming the sleep service safely after the March-May 2020 lockdown period became a priority.

Interventions:

We describe the re-shaping of our paediatric sleep service with the main aim of reducing face-to-face hospital attendance. This included the implementation of new guidelines released by ENT-UK[3] to potentially reduce the number of ambulatory sleep studies performed, and the introduction of a virtual consultation to screen for patients requiring a sleep study.

Results:

We compared data from the 3-month period following re-structure (1st June 2020 - 1st September 2020) to the same period in the previous year (1st June 2019 - 1st September 2019). The proportion of children referred to the sleep service for investigation of OSA undergoing an ambulatory sleep study was less after the re-structure, resulting in a 36% reduction in the number of patients seen face to face (*figure a).*

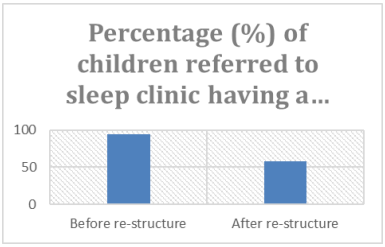

Figure a. *Percentage of children referred to the sleep-disordered breathing clinic from any specialty for investigation of OSA undertaking an ambulatory overnight cardiopulmonary sleep study. 94% (72/77 patients) had a sleep study before re-structure compared to 58% (36/62 patients) after the re-structure.*

In addition to meeting the main aim of reducing face to face attendance, there were fewer patient cancellations (15.6% [12/77] pre-lockdown versus 4.8% [3/62] post-lockdown) and lower first-time failure-rate of studies (7.9% [6/77] before re-structure compared to 3.2% [2/62] after re-structure). We have the capacity to see 9 patients in a 3-hour virtual sleep consultation clinic compared to 6 patients in the previously used 3-hour face to face combined consultation/equipment-fitting clinic.

Conclusions:

Not only are we able to safely run our diagnostic sleep service during the COVID-19 pandemic, but we have a more efficient, convenient and cost-effective service. The COVID-19 era is an appropriate time for adult and paediatric diagnostic services to re-assess their guidelines and the way their services are delivered.

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Pulmonary function after COVID-19 infection and the impact of disease severity

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Intro:
Numerous centres are publishing pulmonary function testing (PFT) in patients after COVID-19. The initial publications showed a reduction in TLco that was more frequently reduced in severe disease and restrictive pattern to PFTs (Mo et al 2020).

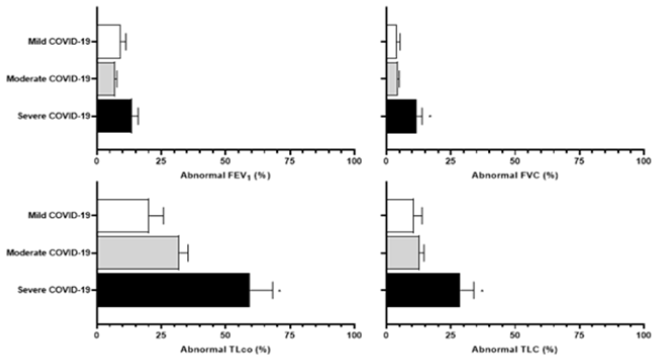
The aim is to investigate the impact of COVID-19 disease severity, as per the World Healthcare Organisation criteria, on PFTs.

Methods:
PubMed and Embase were searched for studies including PFT data in patients who have recovered from COVID-19. To be included in the analysis the FEV1, FVC, TLco and/or TLC data needed to be stratified by severity (mild, moderate, and severe) and presented as frequency below the lower limit of normal (LLN) or <80% predicted. Frequency distribution for each severity was compared by Chi-Squared test, weighted averages are presented as mean (SD).

Results:
2288 records were found; 24 papers measured PFT after recovery from COVID-19, and 9 of those presented data separated by severity and vs LLN or <80% predicted.

	Mild	Moderate	Severe	p
FEV_1	9% (140)	7% (418)	14% (165)	0.09
FVC	4% (140)	5% (418)	12% (165)	0.017
TL_{CO}	20% (152)	33% (46)	65% (254)	<0.0001
TLC	11% (140)	13% (358)	29% (223)	<0.0001

Table 1. Percentage of patients with PFT values <LLN or 80% predicted (n).



Conclusion:

Diffusing capacity abnormality is most abundant in patients who had severe COVID-19, commonly associated with a restrictive pattern.

Stay home; save lives; aid the diagnosis of occupational asthma

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Introduction: Many UK workers have had paid, extended periods away from work due to the COVID-19 pandemic. In those with suspected occupational asthma (OA) this has enabled assessment of serial peak expiratory flow (PEF) over long periods away from their workplace.

Methods: Those who had been followed up by telephone or face-to-face between March and December 2020, had completed serial PEF measurements while at work (pre-March 2020), and then during a long period away from work were included. Workers were asked to complete 4 weeks of readings taking them every 2 hours from waking to sleeping each day, whether in the workplace or not. Data was analysed using the OASYS software program.

Results: 10 patients completed serial PEF measurements during the time periods specified. 7 workers showed an improvement in their mean PEFs with prolonged time away from work. Table 1 shows the results.

Conclusion: Although the diagnosis of OA is usually based on analysis of serial PEFs performed during short, alternating episodes at and away from work, PEFs recorded during longer periods away from the workplace have provided evidence of OA in some patients with equivocal PEF results beforehand and confirmed OA in others.

Exposure	Time since last exposure (months)	Mean PEF at work (off work)	ABC score at work (off work)	Pred PEF
Cleaning agents	5	400 (449)	-2.13 (-6.94)	401
Cleaning agents	0.17	453 (501)	20.5 (4.66)	359
Epoxy glues	4	583 (644)	25.2 (0)	600
Chloramines	4	372 (427)	6.8 (-11.7)	348
Cleaning agents	4	395 (465)	35.0 (0)	322
Diesel	1	576 (627)	30.7 (0)	523
Isocyanates	8	554 (678)	38.5 (0)	500

Table 1. Serial PEF changes at work and away from work

A Virtual SIC: A new way of diagnosing occupational asthma in the COVID-19 pandemic

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We present a novel way of performing a specific inhalation challenge test (SIC) for the diagnosis of occupational asthma. During the COVID 19 pandemic, it has not been possible to admit patients, therefore we performed it virtually. The worker was a 32 year old physiotherapist who started to have problems related to wearing FFP3 or surgical masks introduced at the advent of COVID-19.

Methods: The worker completed virtually supervised FEV_1 and PEF measurements (using the Vitalograph asma-1), then went to a separate room where she wore one of the masks; Day 1: surgical mask for 1.5 hours; day 2 surgical mask for 3 hours; day 3 – rest day; day 4 FFP3 for 3 hours. She performed hourly readings until bed (supervised during working hours). The following week, she wore the surgical mask Monday-Friday during working hours performing hourly FEV_1/PEF. After an 8 week break, an airfed helmet was tested in the same way for a week.

Results: The hoarse voice and tingling tongue started within 1 hour of wearing the surgical and FFP3 masks. She developed chest tightness in the afternoon. She had no change in her FEV_1, and no facial swelling or rash during days 1-4. After day 5, her face swelled and the rash appeared, but her FEV1 remained stable. This continued for a further 2 weeks and took approximately 8 weeks to get back to normal. The airfed helmet produced no symptoms or FEV_1 change.

Conclusion: Remote SICs are possible although caution would need to be taken with the agents used. The cause of the cases' symptoms is still being investigated but could be associated with the waterproofing material.

The development of a spirometry data management interface for the international achieving asthma control in children in Africa (ACACIA) study

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Introduction: The objective of the ACACIA study is to assess and explore asthma control in children in six sub-Saharan African countries using composite scores, FeNO and spirometry. The spirometry for each country (centre) needed to be quality assured before inclusion analysis.

Our aim was to create a bespoke and secure digital interface between the spirometry software and the study database with additional tools for quality assurance of the final spirometry data.

Methods: A central combined database, hosted on Microsoft's Azure Platform in the UK was set up according to local and UK GDPR and ethics requirements. It housed ndd's EasyOne Connect software accessible remotely and only though multi-factor authentication by data managers. Spirometry uploaded from each country was tagged with a country ID and merged into a centre specific and then a combined spirometry database. The data management interface was developed and built to work with the ndd software to extract quality assured spirometry data from the software.

Results: The resulting system allows for instantaneous synchronisation between the interface and the ndd software. Technically acceptable manoeuvres in the ndd software are reflected as such on the interface. The research tool allows for the inclusion or exclusion of whole sets or parts of data, the selection of best FEV_1 and FVC individually, automatic test quality grading and warnings for missing data and BDR times of less than 15 mins, without tampering or changing the original database. It also allows quick visualisation of participant data management status and includes multiple forms of communication between co-reviewers. Once spirometry data has been approved, it is exported and merged with participant's data from other sources, which can be downloaded in an Excel format for analysis.

Conclusion: The development of this system ensured that in a study involving over one million data points, over 3000 children and originating from six different countries, that quality assured spirometry could be used with confidence, by researchers, for analysis without compromising the original data. This interface will be given to each participating centre upon the completion of the study to manage their own spirometry data.

Quality of home spirometry trials using Hand Held Spirometers in CF and Bronchiectasis patients

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Introduction

Spirometry requires maximum patient effort in order to achieve acceptable and repeatable results. Verbal and visual feedback is given to patients to correct technique and improve the quality of spirometry data in outpatient clinics. This is in line with ATS/ERS 2005 criteria on acceptability and repeatability. Sophisticated spirometers provide feedback to the patient on test performance and repeatability at home, in order to obtain good quality data in the absence of a physiologist. To determine the repeatability of home FEV_1 and FVC data collected using the NuvoAir in adolescent patients with CF and bronchiectasis. To compare the NuvoAir independent results to the hospital Vyaire spirometry results.

Method

During this study 30 patients received a NuvoAir spirometer. Patient characteristics were (Mean ± SD); Age 13 ± 3 years, Height 152 ± 14cm, Weight, 45 ± 14kg, FEV_1 % of predicted 77 ± 19%, FVC% of predicted 89 ± 12%, and PEF (L/s) 5 ± 2%. At the initial visit patients were virtually instructed how to use the spirometer and how to perform correct spirometry. The total duration for patients that completed the home spirometry was for 95 assessments ever a 6 week period.

Results

A total of 95 Lung functions were recorded using the NuvoAir device, of these 48.8% were morning tests, while 51.2% were afternoon recordings. We asked patients to perform the lung function tests 30 mins post exercise and physiotherapy. The repeatability criteria for FEV_1 is based on 3-8 blows with the best two results being within 5% or 100mls repeatability. 74% of independent tests achieved the ATS/ERS 2005 repeatability criteria for FEV_1. Average numbers of manoeuvres recorded were 4 blows per session.

We compared the patients' last clinic visit spirometry and their independent home spirometry values. The average PEF remained the same, average FEV_1 were within 4%, and FVC were within 4%, See Table 1.

Parameter	Hospital Vyaire PEF (L/s) Result	Hospital Vyaire FEV1 (%) Result	Hospital Vyaire FVC (%) Result	NuvoAir PEF (L/s) Result	NuvoAir FEV1 % Result	Nuvo Air FVC% Result
Average	6	79	90	6	83	94
SD	2	19	13	2	19	16

Table 1: The difference between their last Hospital Vyaire Result and home NuvoAir spirometry.

Conclusion

Using the NuvoAir device, 73% of CF and bronchiectasis patients were able to produce spirometry at home. This NuvoAir device provides instant feedback which aided the patients when performing spirometry in the absence of coaching and guidance from trained physiologists. All of the sessions did have PEF and FEV_1 measurements recorded, so the feedback message to the patient to 'blow longer' may have aided the expiration time of beyond 1 second.

However, the 30 patients that received a spirometer have had years of experience in performing spirometry in outpatient clinics. To validate these findings we would need to test a different cohort of patients, who have less experience performing regular lung function.

An audit of Primary Care spirometry services in Bristol, North Somerset and South Gloucestershire (BNSSG)

Catherine Dixon, Shannon Robbins, Colleen Riley
North Bristol NHS Trust, Bristol,

Introduction: To be of clinical value spirometry must be performed to a recognised standard (1). Secondary Care clinicians have concerns about the quality of spirometry performed in primary care, thus patients regularly require repeat spirometry in Secondary Care to enable treatment decisions to be made.

Methods: Audit approval was obtained from North Bristol NHS Trust Audit Department. All GP practices in BNSSG received a letter outlining the audit and a questionnaire to complete. The questionnaire was designed to obtain most information required with the rest being obtained from examples of spirometry tests performed in their practice.

Results: Thirty-three of 87 practices returned the questionnaire, of which 94% perform spirometry. The mean number of spirometry tests performed in the previous 12 months was 128 (range 15 – 525).

The majority of practices indicated staff had received spirometry training and the remaining 13% did not answer the question. No staff were on the full, foundation or paediatric level of the National Spirometry Register.

The frequency of equipment calibration, verification and cleaning varied, with 16% only performing calibration/verification of their spirometry equipment annually or never.

Twenty-eight (55%) of the results reviewed were technically acceptable and reproducible, one practice sent no technically acceptable/reproducible results. The most common error was failure to meet end of test criteria (table 1).

Conclusions:

The audit demonstrated that spirometry is performed regularly across BNSSG, but that the quality is variable. These findings support the concerns of Secondary Care clinicians and will be used to inform service developments in BNSSG, particularly the development of diagnostic hubs.

References:

1. Graham et. al. (2019). Standardization of Spirometry 2019 Update. Am J Respir Crit Care Med. Vol 200, Iss 8, pp e70–e88,

Standard	Number of tests not
BEV <5% of FVC or 0.100 L,	3/51
No cough or glottis closure in	6/51
Achieve EOFE criteria	21/51
The difference between the two largest FVC and FEV_1 values <5% or <0.100 L whichever is greater	3/51

Table 1 Review of Spirometry Standards

Reproducibility of Structured Light Plethysmography (SLP) in different positions

Mr Eyas Alhuthail[1,2], Professor Brendan G Cooper[2,3], Doctor James A Stockley[3], Doctor Andrew M Coney[2]

[1]King Saud Bin Abdulaziz University for Health Sciences, College of Sciences and Health Professions, Riyadh, Saudi Arabia, [2]University of Birmingham, Institute of Clinical Science, School of Biomedical Sciences, Birmingham, United Kingdom, [3]University Hospitals Birmingham NHS Foundation Trust, Lung Function and Sleep Department, Birmingham, United Kingdom

Introduction: SLP is a novel technique that involves recording trunk movement during quiet breathing utilising a white light and camera system and may be particularly useful in patients unable to carry out the forced manoeuvre pulmonary function tests. Seated & supine positions are recommended for recording; however, we also investigated standing and assessed the results' reproducibility on different occasions.

Aim: To confirm the reproducibility of SLP recordings in 3 different positions.

Methods: Quiet breathing in 13 healthy volunteers was recorded via SLP (Thora3Di, Pneumacare Ltd, Ely, UK). The same operator repeated the test in the same room on 2 different visits to test the reproducibility. The study protocol application for Ethical Review ERN_19-0016 has been fully approved after been reviewed by the Science, Technology, Engineering and Mathematics Ethical Review Committee at the University of Birmingham. The data were analysed using one way ANOVA with Tukey post hoc test.

Results: Tidal breathing parameters (RR, Ti, Te, Ti/Ttot, and IE50), relative contribution of the chest and abdomen to breathing (CRC, ARC) and breath phase angles (PA) were recorded. No significant differences were found between the visits. Analysis by one way ANOVA demonstrated significant differences between positions in some variables (seated vs supine: Ti/Ttot P< 0.03, PA P<0.01 & standing vs supine: IE50 P<0.05, PA P<0.03).

Discussion & Conclusions:

These results confirm that SLP results are reproducible between visits in all three positions and can be done in any position as seen fit for the subjects condition; however, the significant differences noticed between positions suggest that physiological measures are affected by positioning which can affect the work of breathing and Phase angle, and this needs to be considered especially, while in a supine position.

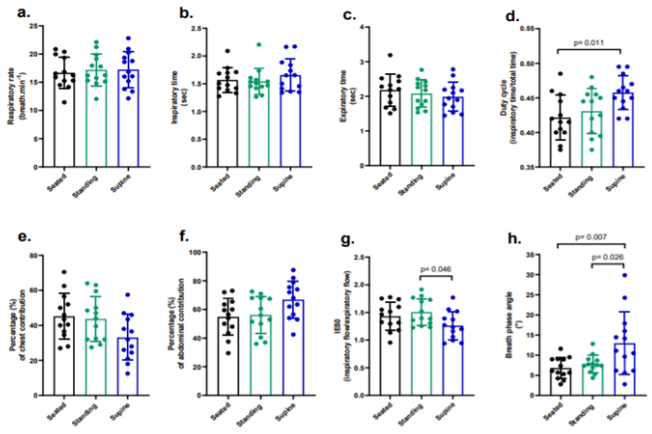

Figure 1. a-h Comparing the Seated, Standing, and Supine Positions: A one-way ANOVA with Tukey post hoc test to depict the difference between the three positions tidal parameters (a. Respiratory rate (RR), b. Inspiratory time (Ti), c. Expiratory time (Te), d. inspiratory to total time ratio (Ti/Ttot), and e. Inspiratory to expiratory flow at 50% tidal volume (IE50)), f-g. the relative contribution of the chest and abdomen to breathing (CRC, ARC) and, h. breath phase angles (PA). Mean ± SD presented with p<0.05 considered significant.

AI-based quality control of spirometry in large epidemiological studies: insights from UK Biobank

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[1]Laboratory of Respiratory Diseases and Thoracic Surgery, Department of Chronic Diseases Metabolism and Ageing, KU Leuven, Leuven, Belgium, [2]ArtiQ NV, Leuven, Belgium

Introduction

Spirometry manoeuvre acceptability in the UK Biobank (UKBB) study was assessed using simple rules-based methods, as well as visual assessment by operators. This may have resulted in a large inter-operator variability that was dependent on the operator's experience. We explored an artificial intelligence (AI)-based software called ArtiQ.QC (Das et al. ERJ 2020) that incorporates visual experience of a trained operator and quantitative guidelines in determining spirometric acceptability in UKBB.

Methods

Pre-bronchodilator curves of 1108 participants from the first assessment visit (2006-2010) were randomly selected. UKBB labels for acceptability were derived using UKBB field ID 3061 ("Acceptability of each blow result"). We used ArtiQ.QC to assess acceptability using the ATS/ERS 2005 guidelines, and compared the ArtiQ.QC labels to UKBB. Subsequently, a technician visually examined each discrepant subgroup ('A' with UKBB=unacceptable and ArtiQ.QC=acceptable, 'B' with UKBB=acceptable and ArtiQ.QC=unacceptable).

Results

9.3% of participants had missing data. In the remaining (1005 participants, 2751 curves), the prevalence of acceptable curves was 57.5% and 53% for ArtiQ.QC and UKBB, respectively, with an agreement of 72% (95% CI=0.70, 0.74). An end of test failure (60%) and a visual presence of an artefact (50%) on the flow-volume curve were the most common reasons AritQ.QC gave for an unacceptable label. On examining 100 randomly selected curves from discrepant subgroups A (N=323) and B (N=452), the technician agreed with ArtiQ.QC 78% and 75% of the time, respectively.

Conclusion

By incorporating visual and quantitative aspects of the ATS/ERS guidelines, ArtiQ.QC has the potential to automate and standardise spirometric quality control in large epidemiological studies. Moreover, it ensures high-quality data are used for further investigation. Finally, it provides holistic feedback on manoeuvre quality, including visual assessment of flow-volume curves.

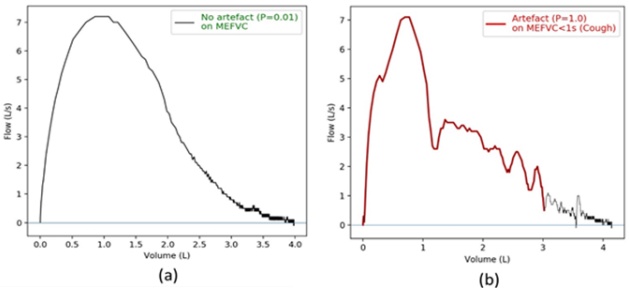


Figure showing two discrepant curves. In (a) curve was predicted as acceptable by ArtiQ.QC but labelled as unacceptable due to large time to peak flow by UK Biobank protocol. (b) Curve was predicted as unacceptable by ArtiQ.QC due to presence of cough but labelled as acceptable by UK Biobank protocol.

Does the method of delivery of nocturnal pulse oximetry affect the quality and reliability of results?

Ms Rachael Leach, Mrs Sara Parsons

St George's University Hospital NHS Foundation Trust,

Introduction

Prior to Covid-19, overnight pulse oximeters were issued in a masterclass setting of twelve patients. Due to infection control requirements, sleep diagnostics were temporarily halted. This predictably caused a large backlog of patients waiting for testing, as well as continued incoming referrals. Three different systems were therefore put into place sequentially to allow testing to continue, however, did the method of delivery of equipment and test instructions affect the quality of the recording of the sleep study?

Method

In March 2020 the following methods of delivery were introduced:

Category 1: Patients were contacted by telephone and full instructions of the test were provided verbally. Equipment was sent out to patients with a written copy of instructions.

Category 2: Equipment was sent out to patients with written instructions only.

Category 3: Equipment was sent out to patients with written instructions, and access to a video demonstration.

Each study was checked by a qualified physiologist to ensure a quality trace was achieved (artefact was removed from analysis). Data regarding the number of tests performed under each regime was then reviewed with the following criteria were applied:

Inclusion criteria:

Traces with more than four hours of reliable data

Exclusion criteria:

1. Patients who had previously had a sleep study, regardless of type of study, or time since
2. Patients who came to the hospital to collect the equipment during lockdown
3. Tests that failed due to the inability to deliver equipment
4. In relation to Category 1 and Category 2, equipment issued by members of staff other than myself
5. Inpatient studies

Results

The results collected are displayed in table 1.

	Pre-Covid	Category 1	Category 2	Category 3
Number of Tests Performed	79	62	66	94
Number of successful tests	73	59	59	88
Number of failed tests	6	3	7	6
%failure rate	**8%**	**5%**	**11%**	**6%**

Table 1: Results showing the comparative failure rates of overnight pulse oximetry following different modes of delivery

Conclusion

The data (table 1) showed that the method of delivery did not impact the quality and reliability of the test. As category 2 had the highest failure rate, it can be inferred that patients did benefit from the presence of visual and/or verbal instructions. It is worth noting from a clinical perspective however that all non-masterclass related sleep study issues take longer for the physiologist to complete, therefore is less efficient in clinic. However, until restrictions change that allow group sessions to occur this is not viable for the time being.

Quality control of polysomnographic scoring in a clinical sleep physiologist team

Dr. Heather Engleman, Mr. Nuno Faria Cachada, Ms. Sara Hacking, Ms. Sarah Martin, Ms. Lauren Irwin, Ms. Neena Derashri

Philips Respironics UKI, Farnborough, UK

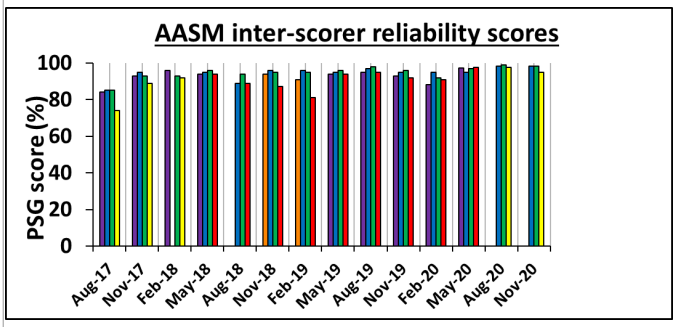
Objectives: To apply an external gold standard for polysomnographic scoring in a team of sleep physiologists, in order to align scoring practice, maintain learning and to assure quality control of scoring output.

Methods: The four sleep physiologist scorers in Philips Respironics' UK Sleep Support Service each complete a monthly sleep study scoring exercise for quality control purposes. Every third month, the assignment is an American Association for Sleep Medicine (AASM) inter-scorer reliability (ISR) exercise. The ISR exercise comprises sleep staging of 200 epochs, with scoring also of respiratory events, arousals and periodic limb movements. Polysomnography (PSG) scoring results are expressed as an overall percentage correct score against the AASM scoring by a panel of gold-standard scorers. A threshold of ≥85% correct is considered acceptable. In between ISR exercises, monthly internal scoring exercises of polygraphy are performed (not reported here). Below-standard scoring performances are addressed by group discussion and reviewing the relevant AASM training video.

Results: The AASM ISR exercise has been completed 14 times in the 39 months since commencement (Fig). Scoring team's average ISR scores were higher than the threshold of 85% in all but the first ISR exercise, and overall significantly higher than this threshold (Sign-Rank test, $p=0.002$). There was a significant trend for improved team scores over time (Mann-Kendall trend test: $p=0.004$).

Conclusions: Use of the ISR assisted a clinical sleep scoring team to improve agreement with an external gold-standard, to avoid scoring 'drift' within the team over time, to perform and maintain learning, and to regularly exercise the full range of polysomnographic scoring skills.

Disclosure: All authors are employees of Philips Respironics UKI.



Early cost utility analysis comparing eXciteOSA to Continuous Positive Airway Pressure in mild obstructive sleep apnoea (OSA)

Ms Deirdre Blissett, Dr Bhik Kotecha
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Background: Continuous Positive Airway Pressure (CPAP) is recommended for mild, symptomatic, obstructive sleep apnoea (OSA). However, adherence to CPAP is low. eXciteOSA, a novel day-time therapy, is demonstrated to be well tolerated and improve symptoms of mild OSA [1, 2].

Objective: We aimed to estimate the cost-effectiveness of eXciteOSA compared to CPAP in mild symptomatic OSA, from a national health service (NHS) England perspective.

Methods: An early stage, cohort, cost utility analysis calculated difference in costs and quality adjusted life years (QALYs), in quarterly intervals in year 1, and annually thereafter for 14 years. Costs included treatment costs (patient set-up, equipment, and monitoring costs) and healthcare costs for untreated OSA. Resource use and cost data were sourced from literature review and clinician feedback. Cost off-sets and utility benefits associated with treated mild OSA were applied to the percentage adherent to each therapy, sourcing adherence rates for CPAP from the literature[1, 2] and for eXciteOSA from recent trials[3, 4] supplemented by assumptions. Recurring treatment costs stopped when patients discontinued treatment. Untreated mild OSA was assumed to incur additional healthcare costs of £39.38 / per patient per year (PPPY)[5]. In the absence of head-to-head trials and limited efficacy data for CPAP in mild OSA[6-8], the utility benefit on treatment was assumed to be the same for both CPAP and eXciteOSA. A utility benefit of 0.021 was applied, replicating an approach applied in prior economic evaluations[9] using change in Epworth sleepiness scale (ESS) [9.0 before eXciteOSA, 5.1 post-eXciteOSA][4]. For eXciteOSA, adherence and discontinuation rates were assumed to be the same and half of those non-adherent to CPAP were expected to continue to incur treatment costs and remain non-adherent to therapy.

Results: After 14 years, average costs per patient were similar and slightly lower for eXciteOSA compared to CPAP (£3,525 with eXciteOSA vs £3,553 with CPAP). eXciteOSA was estimated to result in greater QALYs (0.20 with eXciteOSA versus 0.15 with CPAP), driven by assumed higher adherence rates.

Conclusions / Recommendations: Early economic analysis suggests that eXciteOSA is likely to incur similar costs to CPAP over a 14-year period. eXciteOSA may be a dominant treatment in mild symptomatic OSA populations, especially where patients have poor adherence to CPAP.

Table 1: Base-case results, comparing ExciteOSA to no treatment (per patient, GBP)

	eXciteOSA	CPAP
Treatment costs	**£3,393.43**	**£3,336.45**
Device	£1,186.11	£1,001.06
Consumables	£1,948.16	£1,168.22
Set-up & training	£41.43	£463.66
Annual review / servicing	£217.22	£703.52
Untreated OSA Healthcare Costs	**£131.16**	**£216.55**
QALY gain	**0.20**	**0.15**
Difference in Costs (vs CPAP)	-£28.41	
Difference in QALYs (vs CPAP)	-0.05	
Incremental cost-effectiveness (vs CPAP)	Dominates (cost saving and better outcomes)	

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How effective is Adaptive Servo Ventilation?

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Introduction
Adaptive Servo Ventilation (ASV) devices mimic tidal breathing to eliminate various forms of sleep disordered breathing. ASV is mainly used as a treatment for central/complex sleep apnoea. The authors reviewed data from 44 patients either using or previously using ASV at Nottingham University Hospitals. Resmed S9 CSA and Aircurve10 CS pace wave devices were used.

Methods
Of the 44 patients, 31 were male and 13 were female. Ages ranged between 31 - 87 years with varying diagnoses: obstructive sleep apnoea, central sleep apnoea, motor neurone disease and Cheyne stokes respiration. 30 patients initially used another form of device and were switched to ASV if their original treatment was sup-optimal and there was evidence of a complex sleep disorder, 14 patients only ever used ASV. Of the 30 patients started on another form of device 27 were originally using CPAP, 3 Bi-level.

Results
Results showed that for all patients: baseline AHI = 35.7, ODI = 29.5 and mean SpO2= 92.7%. AHI on original device = 16 and average use on original device = 6.1 hours. In comparison to AHI on ASV = 1.9 events per hour, ODI on ASV = 3.4 dips and average use on ASV = 5.8 hours.
The 27 patients on no form of opiate: baseline AHI = 38 events per hour, baseline ODI = 34 and mean SpO2 = 92%. AHI on original device = 18 and AHI on ASV = 2. 17 patients were on some form of opiate. In this group the baseline AHI = 33 events per hour, baseline ODI = 23 and mean Spo2 = 94%. AHI on original device = 13 and AHI on ASV = 1.

Conclusion
All groups indicated a preference for ASV treatment. ASV was a more effective form of treatment for complex sleep disorders including in opiate use, identifying these patients at an earlier treatment stage will be beneficial for patients.

New sleep diagnostic pathway – going contactless for COVID-19

Ms Ana Gaspar, Mrs Marta Vilaca, Mr Jack Ridler, Mrs Priya Nair, Mr Jonathan Poole, Mr Joel Patasin, Miss Danielle Ally, Mr Gregory Marsh, Dr Alison McMillan

East And North Hertfordshire NHS Trust, Stevenage, Hertfordshire

Introduction

All patients undergoing sleep diagnostic assessment at our NHS Trust from June 2020 have been offered access to the service without a face to face appointment. These changes were implemented as a response to the COVID-19 pandemic to ensure patient safety and continued service provision for the community. We conducted a service audit to assess the impact on the capacity for service provision, quality of the tests and information obtained.

Method

The patient pathway was re-designed to include a telephone clinic appointment collecting pre-assessment information, a diagnostic pack collection from a locker and the return to a drop-off box. The diagnostic pack included a respiratory polygraphy or oximetry device, instructions and questionnaires.

We compared data for patients undergoing assessment on October 2019 and October 2020.

Results

The two groups audited have similar gender distribution, mean age, mean BMI and mean ODI. The new protocol slot duration reflected shorter telephone appointment times where observations such as blood pressure were no longer performed. This led to an increase of 24% in clinic capacity. However, fewer studies were completed due to a reduction in referrals received. The % of failed studies, although higher in the second group, remained low. The data reflects a 12.6% reduction in % of information gathered, specifically baseline observations and questionnaires either unavailable or incomplete. It is also worth considering that observations such as height and weight were reported by the patients instead of measured and this can be unreliable.

	Parameter	*October 2019 n = 107*	*October 2020 n = 82*
Sample Characteristics	% of male gender	64.48%	64.63%
	Mean age	50.83	49.55
	Mean BMI (kg/m^2)	32.00	32.36
	Mean ODI	17.13	18.62
Audit results	Weekly clinic capacity	38	50
	Number of studies completed	107	82
	% of failed studies	0.93%	2.43%
	% of pre-assessment information completed	97.48%	84.88%

Conclusion

The change in patient pathway was clearly designed for patient safety and has improved clinical capacity without a significant increase in failed studies. However, it has had a negative impact on diagnostic data quality.

The clinical impact of this has not yet been assessed. Future studies could address whether the reduction in data quality may lead to clinically relevant outcomes.

Development of a Drive-Thru Service for Sleep Diagnostic Studies During the COVID-19 Pandemic

Dr James Stockley, Mrs Theresa Cunnington, Mrs Jodie Hunt, Prof Brendan Cooper

University Hospitals Birmingham NHS Foundation Trust, Birmingham, UK

INTRODUCTION: During the first COVID-19 national lockdown, our sleep service ceased entirely, resulting in a backlog of nearly 700 appointments. To facilitate the recommencement of the sleep diagnostic service in June 2020, we developed a novel “click-and-collect” drive thru service for the collection of equipment without the need to enter the hospital. This study was conducted during the early phases of this new service with the aim of maximising its capacity and efficiency, using formal Plan-Do-Study-Act (PDSA) cycles.

METHODS: The process involved a preliminary 30 minute telephone call to establish feasibility for patients and record demographic and clinical information before appointments were booked. The study was conducted over 10 weeks, comprising 4 complete PDSA cycles (each of 2 weeks duration). Fortnightly meetings were held to monitor progress and plan the next cycle but communication was maintained throughout. The primary outcome was the total number of studies performed daily. Initial targets of 8 oximetry (Minolta 300i, Stowood SI Ltd, Oxford, UK) and 6 WatchPat (Itamar Medical Ltd, Amsterdam, Netherlands) studies (14 total) per day were set.

RESULTS: Figure 1 shows the total number of studies performed during this period. Discussions at the end of each two-week PDSA cycle raised a number of important issues. Most notably, cold calling patients was largely unsuccessful but this was effectively resolved by sending appointment letters for the telephone calls. The development of electronic worksheets significantly reduced takt time, although the telephone call was still the rate-limiting step.

CONCLUSIONS: The drive thru click-and-collect service has proved largely successful. Major issues were quickly identified and resolved. We failed to reach our target of 14 studies per day on all but one occasion but this was due to staffing issues. The service now operates so effectively, we are performing more sleep studies that before the COVID-19 pandemic.

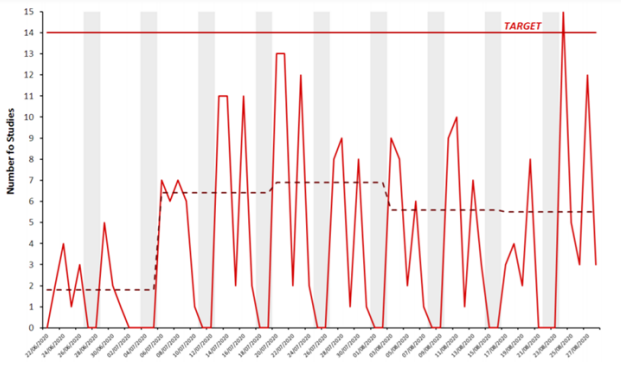

Figure 1: A Statistical Process Control (SPC) Chart for the total number of click-and-collect sleep studies during the first ten weeks (4 complete PDSA cycles) of service, showing the mean for each cycle (dotted line) and the target number (14). Grey areas indicate weekends when our department was not open.

Benefits of a drive through overnight oximetry service during the pandemic of 2020-2021

Miss Bethany Swaffield, Miss Manisha Perera, Miss Lauren Kimberley, Mrs Jessica Swan, Mrs Karena Cranstone, Mrs Rachel Johnson, Miss Natalie Wilson, Miss Emily Seaman, Mr Mark Unstead
Royal Berkshire Hospital, Reading, United Kingdom

Introduction:
Home sleep studies have traditionally been issued face-to-face (F2F). During COVID-19 referrals increased by 2%, therefore, a safe effective way of resuming clinical activity was needed. The Royal Berkshire Hospital built an external tent, to issue overnight oximeters. Previous studies have shown oximetry to be an effective diagnostic tool for sleep apnoea (Hang et al., 2015). This study aims to compare the effectiveness of Drive-through clinics (DTC) with F2F appointments.

Method:
451 patients collected a sleep study from a DTC. Clinics of ~10 patients ran at 10-minute intervals (between July 2020-April 2021) with F2F services also running inside. Epworth Sleepiness Scale and a lifestyle questionnaire were completed prior to clinic. Physical measurements were taken and video link provided to demonstrate usage. Following 2 nights, equipment was returned via a 24 hour drop off point. Sufficient data required ≥ 4 hours per night. Oxygen Desaturation Index (ODI) and Mean SpO2 were added to a Sleep Reporting List for consultant review.

Results:

Group	BMI	ODI	% of two -night studies	Failure Rate %	N of days to return equipment	Mean difference between two-night studies (ODI)
Drive through	40.3 (18-58.3)	16.27 (0-75)	91.98%	2.44%	3	0.98
Face to Face	44.2 (17-61.2)	13.69 (0-65)	87.80%	6.00%	7	0.94

Table 1: Comparison made between patients attending DTC and F2F appointments. BMI and ODI of a combined gender are presented as mean (range). Percentage of two-night studies, failure rate, and number of days to return equipment and mean difference of ODI are presented.

Conclusion:
Data gathered from the study show DTC provided an effective method of diagnostic testing for sleep apnoea compared to F2F settings. A low failure rate was evident with a 2.44% reduction in DTC, resulting in fewer repeat studies. Figures from each individual study are consistent over the 2 nights, reducing risk of variable results. There is a significant improvement on the effectiveness of sleep studies when performing a DTC clinic instead of a F2F consultation. The figures indicate the DTC will aid the recovery of services post COVID, allowing for a higher turnover of data to be analysed and a more effective treatment pathway to be implemented.

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Hang, L., Wang, H., Chen, J., Hsu, J., Lin, H., Chung, W. and Chen, Y., 2015. Validation of overnight oximetry to diagnose patients with moderate to severe obstructive sleep apnoea. BMC Pulmonary Medicine, 15(1).

Continuous Positive Airways Pressure (CPAP) - Drive Thru Collection Clinic (DTCC).

Mrs Karena Cranstone
Royal Berkshire NHS Foundation Trust

INTRODUCTION
With a 2% increase in sleep referrals and COVID-19, a new safe, effective way of working was required. Historically CPAP has been issued at face-to-face (F2F) appointments. The Royal Berkshire Hospital erected a large tent which the respiratory physiology team used for CPAP DTCCs. The aim of this study is to compare compliance and efficacy from DTCC with F2F appointments.

METHOD
Between 12/11/20 & 18/3/21 N=58 (44M & 14F) patients with confirmed Obstructive Sleep Apnoea (OSA) attended DTCC. Average Oxygen Desaturation Index (ODI) 15.45 (4.47-46), age 52.1yrs (29-86), BMI 31.92 (21-55), Mean SpO2 93.81% (81.68-96.69). Prior to DTCC patients were asked to watch a demonstration video, paperwork was completed and machines were pre-assigned. 10 min. appointments were allocated; patients drove through to collect their machine, were consented to AirView, mask size was measured and post CPAP questionnaire and brief instructions were given. Remote reviews were performed at ~4 weeks; use of ≥ 4 hrs/p/n [1]. Weaver, TE) indicated compliance. Post ESS obtained where possible and absolute Δ in ESS calculated to identify clinical outcomes. Data was analysis using Microsoft Excel.

RESULTS
A compliance of 50% was achieved from DTCC, N=29 (22M 7F), 29 patients either returned the machine, did not use or were non-compliant; (22M & 7F). ESS reduced by 5.36 (50.93%) at first review, however only 35 post CPAP questionnaires, including ESS, were returned by patients. Average time for F2F appointment (~45 mins.) was compared to DTCC (~15 mins.).

Avg. hrs used per night	AHI	Pre ESS	Compliant Post ESS	Absolute Δ ESS	% Δ in ESS	Average time per patient (mins.)
3.91	6.16	10.58	n29 (50%)	5.36	-5.58	48.97	-30
0 – 15.3	0 – 66.3	1 to 22	44M & 7F	0 to 16	0 - 16	0 - 100	DTCC = 15
2.99	11.05	4.96		4.00	4.05	28.44	F2F = 45

Table 1. Results and key outcomes.

CONCLUSION
DTCC is a time efficient alternative to traditional F2F appointments with a reduction of ~30 minutes per patient. This study suggests there is a small reduction in compliance and clinical outcomes. A previous local study indicated a CPAP compliance of 61% [2], while this study shows a 50% compliance. The DTCC will aid recovery post COVID, allowing for increased outpatient capacity while reducing footfall in the hospital.

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Short of circuits: a benchtop assessment of modified CPAP mask and circuits as part of pandemic response.

Mr Mark Unstead[1], Karena Cranstone[1], Lauren Kimberley[1], Jessica Swan[1], Emily Seaman[1], Bethany Swaffield[1], Manisha Perera[1], Natalie Wilson[1], David Cook[1], Marcus Durand[1], Ian Rechner[1], Simon Coleman[1], Matthew Richards[2]

[1]Royal Berkshire NHS Trust, [2]Cisco Systems UK

Introduction

Continuous Positive Airway Pressure (CPAP) has been proposed as a strategy that protects intensive care capacity in Covid-19 (1). As a result, critical care respiratory support consumables have become high demand stock items. In March 2020, home CPAP consumables were assessed for conversion into acute in-patient CPAP circuitry. This study assessed the modified mask/circuits (MC) with commercially available CE marked acute CPAP items.

Method

Vented home CPAP masks were converted into non vented with o-rings occluding the leak. Circuit CO_2 leaks were adapted from an in-line bacterial/viral filter. Two 3-4mm holes were created in the side of the filter, distal from the patient, allowing expired gas to escape after passing through the filter media. The modified mask/circuit was assessed on a healthy human volunteer under consultant supervision. The mask/CO_2 leak assemblies were compared with CE marked circuitry using a modified resus model and 1.0 litre model lung with standardised tidal volumes and a NIPPY4 machine.

Results

			F_iO_2 with O_2 entrained at flow rate of:					
Circuit	**VT (ml)**	**Leak (L/min)**	**4 L/min**	**6 L/min**	**8 L/min**	**10 L/min**	**12 L/min**	**15 L/min**
MC	805.2	21.4 (19-22)	30.6 (30-31)	37.0 (36-38)	43.2 (42-46)	47.2 (47-48)	53.4 (51-55)	60.2 (59-61)
Respironics Trilogy	791.0	21.6 (19-23)	30.2 (29-31)	34.6 (31-37)	39.2 (37-41)	43.8 (41-48)	52.6 (46-58)	64.6 (60-67)
Fisher and Paykel (RTO17)	855.4	19.8 (19-20)	30.8 (29-31)	33.6 (32-35)	37.8 (35-39)	43.4 (42-44)	49.0 (47-51)	59.4 (58-61)
NIPPY	798.4	20.6 (20-21)	33.8 (33-34)	36.8 (33-40)	45.6 (44-47)	49.4 (47-53)	53.6 (51-55)	66.8 (62-67)
Armstrong	725.2	20.3 (19-22)	30.8 (30-31)	36.6 (35-37)	42.6 (39-44)	49.6 (45-52)	52.4 (49-55)	65.4 (62-67)

Table 1: Circuit Leak and FiO2 for MC and CE circuits. Mean (range) values displayed for CPAP of 10 cmH_2O and 20 L/min Minute Ventilation.

Conclusion

Modified mask and circuits give a safe, effective alternative way of delivering acute CPAP in situations of critically low stock levels. Although the FiO2 delivery was lower in real-time patient use, the methods used in this study enabled rapid comparison between multiple circuit options.

References

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Continuous Positive Airway Pressure (CPAP) adherence prior to and following the first surge of the COVID19 pandemic

Mr Ben Streatfield, Mr Richard Glover, Mr Adam Smith, Mrs Julie Lloyd
University Hospitals Birmingham, UK

Introduction: Obstructive Sleep Apnoea (OSA) is a common respiratory disorder affecting 2-4% of the adult population, and the use of CPAP remains the gold-standard in long-term management[1]. COVID19 has generated several challenges for the administration of CPAP including, but not limited to; schedule changes due to social distancing, adoption of remote monitoring as a routine tool, and creation of strict Aerosol Generating Procedure (AGP) guidelines. The purpose of this study is to identify to what extent adjustments to normal operating procedures due to COVID19 have impacted treatment adherence in those using CPAP.

Methods: 153 patients (83 PRECOVID19; 70 POSTCOVID19) were identified from the hospital appointments system. Baseline Apnoea hypopnoea index (AHI), Epworth sleepiness score (ESS), and CPAP compliance in the first month of treatment was recorded and compared across the two groups. Mann Whitney-U was used to compare compliance and AHI, student's t-test was used to compare ESS and Pearson chi-square was used to compare the proportion of compliant patients in each group. 49 patients with incomplete datasets were excluded from statistical analysis, leaving 106 patients (44 PRECOVID19; 62 POSTCOVID19); however, these patients will be included in the final results.

Preliminary Results: There was a significant difference (p = 0.024) between PRECOVID19 and POSTCOVID19 for average use (4.0hrs [1.6, 5.3] vs. 5.0hrs [2.4, 6.3], respectively). There was a significant difference (p = 0.047) between PRECOVID19 and POSTCOVID19 for compliance (50% vs. 69%, respectively).

	Pre COVID n44	**Post COVID n62**	**p value**
AHI	27.0 [18.5, 49.5]	39.8 [14.2, 49.9]	0.592
Baseline ESS	11.4 (5.1)	12.3 (4.8)	0.343
Compliance (hours)	4.0 [1.6, 5.3]	5.0 [2.4, 6.3]	*0.024
Compliant (%)	22 (50)	43 (69)	*0.047

Table 1. Data shows results from patients commenced on CPAP pre and post COVID. Continuous variables are presented as mean (SD) or median [IQR]; categorical variables are presented as frequency (%). Compliant is defined as an average nightly CPAP usage >4 hours. *signifies a significant difference between the two groups

Conclusion: Adjustments to standard operating procedures due to COVID19 resulted in a significant and meaningful improvement in CPAP adherence. Although the exact cause for this change is unclear and likely multifaceted, in keeping with previous research, this study highlights that adoption of remote monitoring software as a routine tool may be beneficial for CPAP adherence[2, 3].

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Management of Patients on Continuous Positive Airway Treatment: Quality Improvement project on Remote Monitoring in Obstructive Sleep Apnoea

Dr Abubacarr Gassama, Ms Shirley Coelho, Mr Maximillian Thomas, Dr Rahul Mukherjee
Birmingham Heartlands Hospital, Birmingham, United Kingdom

Introduction:
Obstructive sleep apnoea (OSA) is the most common sleep disorder and mainly caused by the partial or complete closure of the airway during sleep leading to sleep fragmentation and arterial hypoxemia. Continuous positive airway pressure (CPAP) is the recommended treatment for OSA. It helps to splint the airway open thus maintaining upper airway patency. Despite the effectiveness of CPAP to treat OSA, compliance is a major issue for most patients. Untreated OSA increase risks of stroke and cardiovascular diseases. The arrival of remote monitoring provides a new tool to aid patients to improve their compliance. A patient is deemed compliant if the average usage ≥ 4 hours and 70% of days used ≥ 4 hours per day. We aim to explore the impacts of telemonitoring with physiologist intervention on CPAP compliance (% of days with ≥ 4 hours use), adherence (% of nights with CPAP use) and average usage and identify predictors of compliance.

Method:
Control group included all patients started on CPAP therapy from the months of February, March and April 2019 (n=142) and the intervention group included all patients set-up on CPAP from May, June and July 2019 (n=166). The control group received basic care whereas the intervention group was reviewed 4–6 weeks post CPAP set up with telephone consultation or a letter. 30 days compliance, average usage and adherence was measured pre and post telemonitoring (TM) for both groups. Age, gender, Epworth Sleepiness score (ESS), body mass index (BMI) and apnoea and hypopnoea index (AHI) at diagnosis were recorded for all patients. Wilcoxon Rank Test and Mann-Whitney U test were used for statistical analysis.

Results:
No significant difference was observed in age, gender, AHI, ESS between the groups. Results were reported as mean ±SEM. There was a significant reduction in compliance (55.7 ±3.0 Vs 51.8 ±3.2 % of days ≥4 hours; p value= 0.0072), average usage (255 ±12.8 Vs 236 ±13.7 Minutes; p value =0.0003) and adherence (78.7 ±2.1 Vs 69.8 ±2.9 % of days use; p value= 0.0001) in control compared to the baseline. Interestingly, there was a significant increase in compliance (50.8 ±2.5 Vs 56.1 ±2.9 % of days ≥4 hours; p value= 0.0075) and average usage (234 ±10.4 Vs 252 ±12.1 Minutes; p value= 0.0456) in TM group compared to the baseline, though adherence (73 ±2.2 Vs 74 ±2.5 % of days use; p value= 0.221) was not significant. In addition, more people returned their CPAP machine in the control group (15%) compared to the intervention group (10%) though the difference was not significant.

Conclusion:
TM is effective at improving compliance with CPAP therapy thus suggesting a potential role of sleep physiologists in CPAP remote monitoring in the community setting. Future investigations need to consider longer-term monitoring to assess whether compliance might decrease similar to what was observed in the controls.

How to improve CPAP compliance in Patients with Learning Disabilities

Mrs Suzannah Torres
Wythenshawe Sleep Service, Wythenshawe Hospital, UK

Introduction: A Reasonable Adjustment pathway was created with the support of Manchester & Salford Learning Disability teams; to specifically adapt sleep service information to learning disability patient requirements:

Methods:
- Offering one to one approach with the same clinical physiologist.
- The appointment slots were booked on days where the waiting room was quieter. Clinic rooms with beds were used to simulate night time routine.
- All Patient Information was adapted to easy read format.
- Flash cards and audio visual support was given as follow up information.
- Follow up calls were complete one week & one month after set up.

Findings:
- Pre CPAP AHI was reduced by 54% across the patient group by achieving CPAP compliance.
- 70% of patients achieved a 90 % reduction in AHI who were otherwise not being treated.
- 70% of patient feedback rated the one to one approach as being most important to them.
- 57% of patient feedback rated 'very satisfied' with the service they had experienced.

Conclusion:
Patient therapy compliance was improved greatly by providing a one to one pathway specific to the patients learning needs. This helped to improve CPAP compliance by 54% in patients who would otherwise be non-compliant in our standard CPAP clinics.

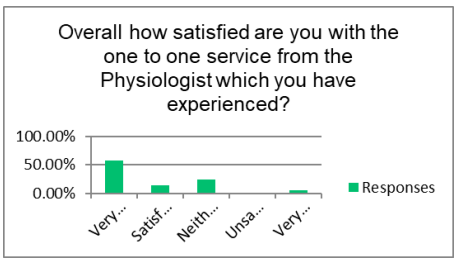

Figure 1. Patient feedback questionnaires regarding the new service pathway. Feedback questionnaires were sent to a total of 80 patients. We received approximately 25% response. The Feedback was overwhelmingly positive.

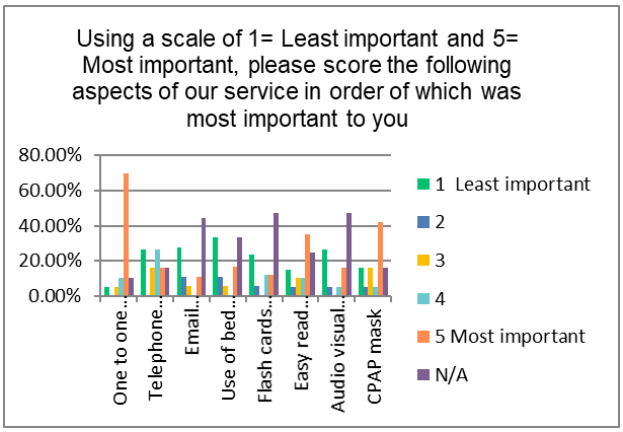

Figure 2. Patient Feedback questionnaire, in order of importance regards the different aspects to the new service pathway implemented. Patients preferred most the one to one approach, followed closely by cpap mask guides and easy read guides. The significance of this was that patients only communicated to one physiologist leading the pathway.

Magnitude of sleep quality and associated factors among undergraduate medical students in Nepal; a cross-sectional study

Mr. Kiran Paudel[1], Mr. Tara Ballav Adhikari[2,3], Mr. Prem Basel[1]

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Background

Poor sleep quality is strongly associated with students' learning abilities, poor academic performance and poor interpersonal relationship. However, little is known about this issue in Nepal. This study aimed to identify the factors associated with poor sleep quality among undergraduate medical students in Nepal.

Method

A web based survey was conducted among 212 undergraduate medical students at Maharajgunj Medical Campus, Institute of Medicine (IOM), Kathmandu, Nepal between in March 2021. Poor sleep quality was measured using a 19-item Pittsburgh Sleep Quality Index (PSQI). Multivariate logistic regression analysis was done to determine the risk factors of poor sleep quality.

Result

In this study, 144 males (67.9) and 68 females (32.1) undergraduate medical students took part. The mean global score of sleep quality was 5.4±3.3, and 38.2% of the students were identified as poor sleepers. Factors like being depressed (AOR= 4.5, 95% CI; 1.2-5.4), current alcohol consumption (AOR= 2.5, 95% CI; 1.8-10.8), poor academic achievement (AOR= 3.4, 95% CI; 1.1-10.9), and fourth year students' (AOR= 3.6, 95% CI; 1.1-11.8) were associated with poor sleep quality at p-value <0.05. However, there was no statistically significant difference observed with sex, smart phone use, current habit of smoking, self-reported health problems, and sharing bed with others.

Conclusion

Poor sleep quality is common among undergraduate medical students of Maharajgunj Medical Campus, IOM. Routine screening of sleep quality and depressive symptoms is warranted. Specific sleep quality promoting programs should be incorporated early on in medical education.

Key words: depression, sleep quality, medical students, Nepal

Case Study: A patients' perspective of CPAP therapy pre and post bariatric surgery

Ms Rachael Leach, Mrs Sara Parsons
St George's University Hospital NHS Foundation Trust

A 27 year old patient, who is also a respiratory physiologist, presented to the sleep clinic in 2017 due to loud disruptive snore reported by partner. Patients' medical history included probable asthma, due to frequent and recurrent chest infections for several years (treated with Symbicort BD and Salbutamol PRN). Prior to appointment, patient had undergone an overnight pulse oximetry for one night, which was inconclusive. Increased pulse rises throughout the study suggested sleep disturbance, therefore patient performed a polygraphy in June 2017. Following normal CBG results, and a diagnosis of severe obstructive sleep apnoea, patient commenced CPAP therapy.

CPAP minimum pressure was titrated to 14.0cmH_20. Patient was compliant with CPAP therapy and AHI was optimised. In October 2018 patient underwent Roux-en-y Gastric Bypass surgery. Less than a month later, patient was struggling with CPAP due to high pressure; use of ramp function evident, which had not previously been used. This was despite only a 9kg (5.8%) weight loss. Minimum pressure was reduced to 8.0cmH_20; AHI remained controlled, and CPAP compliance increased.

As a respiratory physiologist, the patient performed regular biological controls in their department, and continued this during their weight loss. The pulmonary function results demonstrated an improvement post weight loss surgery (FEV_1 18%, FVC 14%, FRCpleth 48%, ERV 35%, TLC 23% increase).

Once the patient had achieved 70% excess weight loss (total of 64kg) patient abstained from using the CPAP for five nights, and repeated polygraphy off CPAP in July 2020 (table 1).

	Weight (kg)	BMI (kgm^{-2})	Collar Size (cm)	ESS	AHI	ODI	Snore (%)	Estimated sleep efficiency (%)
Pre Surgery	150.2	54.0	40	7	45.4	42.3	67.5	52.3
Post Surgery	99.0	35.5	35	7	7.6	3.0	5.2	96.7
		%change	-13%	0%	-83%	-93%	-92%	85%

Table 1: Patient demographics and polygraphy results pre- and post-weight loss surgery.

There was a significant improvement in all parameters of the pulmonary and sleep investigations specifically the AHI and snore, and as such the estimated sleep efficiency. CPAP therapy was terminated. No changes were noted in daytime symptoms post weight loss, however, patient no longer requires a Symbicort inhaler, and has seen a marked improvement in both the frequency and severity of chest infections experienced. This is likely due to the overall improvement in pulmonary function, with large increases in ERV and FRCpleth as expected with weight loss.

A role for cardiopulmonary exercise testing in detecting physiological changes underlying health status in Idiopathic pulmonary fibrosis: a feasibility study

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[1]Bristol Academic Respiratory Unit, University of Bristol, [2]North Bristol NHS Trust, Bristol

Introduction: There is limited data on the use of cardiopulmonary exercise testing (CPET) as a predictive tool for disease outcomes in patients with idiopathic pulmonary fibrosis (IPF). We investigated the feasibility of undertaking CPET and the relationship between CPET outcomes and quality of life measurements in patients with mild and moderate IPF.
Methods: Patients completed lung function, six minute walk (6MWT), CPET, health status questionnaires (K-BILD and VAS cough and breathlessness) and patient-reported outcomes (IPF-PROM). Patients with mild IPF repeated the study investigations at 12 months.
Results: Twenty-one patients (mild n=13 and moderate n=8) completed the study. At baseline, total K-BILD and total IPF-PROM scores significantly correlated with 6MWT distance, but not baseline FVC %predicted, TLco %predicted, baseline or minimum SpO_2. VO_2 peak/kg at AT positively correlated with total scores, breathlessness/activity and chest domains of the K-BILD questionnaire ($p < 0.05$). VO_2 peak significantly correlated with total IPF PROM scores and wellbeing domains ($p < 0.05$), with a trend towards statistical significance for total IPF-PROM and VO_2 peak/kg at AT ($p = 0.06$). Repeat CPET testing demonstrated statistically significant changes compared to baseline values (Table 1).

	Baseline (n=13)	Follow up (n=13)	*p* value
CPET parameters			
VO_2 peak (ml/kg/min)	21.6±2.9	19.1±2.8	0.017
VO_2 peak at AT (ml/kg/min)	14.2±3.2	11.8±1.6, n=12	0.044
VE peak (L/min)	75.3±20.9	66.1±21.6	0.007
VE peak % pred	75.5±13.2	65.9±12.2	0.007
VE/VCO_2 at AT	29.7±3.1	31±4.6, n=12	0.353
Minimum O_2 saturation during CPET (%)	91.5±5.5	87.9±6.6, n=12	0.182
Peak Work (W)	106.9±26.3	90.8±25.9	0.022
Peak Work (% predicted)	44.3±6.9	37.7±8.5	0.002
HR (bpm)	142.3±24.0	133±22.3	0.040
HR (% predicted)	98.7±16.9	91.8±16.8	0.022
BR max (L/min)(median, (IQR))	21.8 (12.4–34.2)	33.8 (20.2–55.7)	0.0002
6MWT parameters			
Distance achieved (m)	346.9±73.8	340.8±72.4	0.563
% theoretical distance (m)	76.4±18.3	76.0±16.8	0.872
Lung function parameters			
FVC % predicted	98.8±8.5	93.4±10.3	0.010
TLco % predicted	62.3±9.4	59.3±11.8	0.161

Table 1 baseline and 1 year follow up data for patients within mild group (those with matched tests)
All values are shown as mean ± standard deviation, unless otherwise stated. Paired t-test was used for parametric data, whilst Wilcoxon matched pairs signed rank test was used for non-parametric data. A $p < 0.05$ was considered statistically significant.

Conclusions: We demonstrated that CPET is feasible in patients with mild to moderate IPF without significant adverse events. CPET measures of VO_2 peak correlated with both baseline and change in K-BILD measurements at one year, despite relatively stable standard lung function, suggesting its potential sensitivity to detect physiological changes underlying health status.

References: 1. Triantafillidou C, et al. The role of cardiopulmonary exercise test in IPF prognosis. Pulm Med. 2013;2013:514817.

An RER of 1.05 should not be used to determine maximal effort during CPET

Max Thomas[1], Dr James Hull[2], Dr Karl Sylvester[3]
[1]University Hospitals Birmingham, UK, [2]Royal Brompton and Harefield NHS Foundation Trust, London, UK, [3]CUH & Royal Papworth, Cambridge, UK

Introduction: A recent ERS statement on standardisation of cardiopulmonary exercise testing (CPET) in chronic lung diseases (Radtke et al 2019) discussed the criteria for determining maximal effort. A CPET with a respiratory exchange ratio (RER) >1.05 is considered maximal using these criteria; $V'O_2$ <85% predicted, V'E >85% predicted, and HR <90% predicted were considered abnormal responses if the test is maximal.
We hypothesise that using an RER >1.05 as maximal will result in misinterpretation.

Methods: Retrospective analysis of CPETs performed at Birmingham Heartlands Hospital in 2019. Inclusion criteria: patient limited, RER >1.15 at peak, >6 mins. Exclusion criteria: highly variable RER indicating dysfunctional breathing.
$V'O_2$, V'E, and HR were measured at RERs of 1.05, 1.15 and peak, and were compared with Friedman tests.

Results: CPET was performed in 422 patients. 199 had an RER > 1.15 at peak. 23 patients were excluded due to dysfunctional breathing. The indication for testing was pre-operative assessment in 117 patients and CPET was for diagnostic purposes in 59 patients. Mean (SD) age = 61.4 (16.9) years, BMI = 27.7 (5.4), CPET duration 9.4 (1.8) mins; gender (F:M) 50:126.

	RER 1.05	RER 1.15	Peak	p
$V'O_2$ %pred	54.25 ± 22.2	65.2 ± 25.8	76.1 ± 30.7	<0.0001
V'E %pred	38.4 ± 17.8	53.7 ± 22.25	65 ± 24.44	<0.0001
HR %pred	77.55 ± 17.55	86.9 ± 16.17	91.46 ± 16.95	<0.0001

Table 1. CPET Data (median±IQR)

Of the 59 patients that were investigated for cause of breathlessness, 37% were normal at peak exertion based on the ERS criteria for abnormality. At an RER of 1.05 this was 3.4% and at an RER of 1.15 this was 25.4%.

Of the 117 preoperative assessments, 88 had a $V'O_2$peak >15 ml/min/kg and could be considered low risk for surgical intervention. At an RER of 1.05, 70% of these patients would have been considered high risk; 30% would have been considered high risk at RER 1.15.

Discussion: Using an RER of 1.05 an indicator of maximal effort underestimates some patients' true exercise capacity. This will have an impact on diagnosis and risk stratification.

ARTP Annual General Meeting Minutes

Friday 2nd July 2021. Zoom Meeting. Chair: Julie Lloyd

Welcome

Julie Lloyd (JL), ARTP Honorary Chair, welcomed the audience that totalled 78 people and outlined the agenda for the AGM and the annual report that had been sent to all members prior to the AGM.

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

JL informed that the total number of new ARTP members was 69; a slight decrease from 2019 which was likely due to the global pandemic and challenges faced in attending online events and attracting new members. JL confirmed that numbers of renewed ARTP members remains stable.

JL acknowledged the extraordinary efforts which the respiratory and sleep workforce have made during the global pandemic.

Annual Accounts 2019/20

JL gave an overview of the accounts, which had been made available to members before the AGM, where there has been a small decrease in the total funds carried forward in 2020.

JL advised that there had been a number of challenges in the financial year due to the global pandemic, which have resulted in a significant reduction in income, which is not yet reflected in the current accounts.

JL reminded those present of the membership categories that have voting rights (allied, associate or life member). All eligible members present voted to accept the accounts with no objections.

JL gave her thanks to Mike Lang (ARTP Treasurer), Executive Business Support (ARTP Support Services) and Mark Hubbocks (Financial NED) for their support with the ARTP accounts.

Trustee Voting

The role of ARTP Treasurer was up for re-election and it was proposed that Mike Lang would remain in post. All eligible members present voted in favour of this with no objections so the nomination was accepted.

The role of ARTP Vice Chair was also up for re-election and it was proposed that Joanna Shakespeare would remain in post. All eligible members present voted in favour of this with no objections so the nomination was accepted.

Executive Committee Updates

JL outlined further committee changes with a new Examinations Chair (Marie Belcher), Examinations Vice Chair (Mark Unstead), Education Vice Chair (Helen Purcell), Workforce Vice Chair (Max Thomas) and Spirometry Vice Chair (Richard Glover). She expressed her thanks to the outgoing post holders for their hard work during their tenure.

Association Updates

JL advised that the ARTP Statement on Pulmonary Function Testing 2020 was published in BMJ Open and thanked Dr Karl Sylvester and Keith Butterfield for their hard work on this.

JL informed that draft ARTP guidance on cardiopulmonary exercise testing is currently under review.

JL advised that the ARTP COVID-19 Group have published evidence guidance throughout the pandemic to support ARTP members and other professional groups. JL gave her thanks to the ARTP COVID-19 Group for their commitment and dedication to producing this work despite the challenges they faced.

JL thanked all ARTP Committees for their continual hard work. JL gave thanks to the Events Committee for their hard work with organising the first ARTP virtual conference. JL also thanked EBS for their events and administrative support.

JL informed that final arrangements for the ARTP 2022 Conference have not been made due to the pandemic, but advised that it is hoped that a face to face conference can take place in Spring 2022.

AOB

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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1. When compared to cardboard mouth pieces. 2. Independently tested by Nelson Laboratories. Full report available on request.

A GLOBAL LEADER IN RESPIRATORY DIAGNOSTICS