August 2020 VOLUME 21, ISSUE 2

ARTP

Association for Respiratory Technology & Physiology

Inspire

INSIDE THIS ISSUE:

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INSPIRE is published three times per year: 1st April, August, December. Deadline for articles two weeks prior to publication.

ADVERTISING RATES Please contact ARTP Administration for more information on admin@artp.org.uk or see the ARTP website http://www.artp.org.uk/en/about-artp/admin/advert-rates.cfm

FIRST WORD

VOLUME 21, ISSUE 2. AUGUST 2020

I hope you are all keeping well and are perhaps considering a summer break, even if it is at home, to relax after a difficult few months (since the previous issue in fact). This issue reflects the fact there is (nearly) only one topic to cover.

The previous 'Inspire' was published in the early days of the COVID-19 situation when it was unclear exactly how events would develop and how we, as a profession, would cope. Professor Cooper's words in the 14th April 2020 AHCS VOX email newsletter summed up how I suspect many respiratory and sleep units were feeling at the time and I found them inspiring. You can read the article here (https://www.ahcs.ac.uk/news-events/vox-healthcare-science-newsletter/vox-archive/).

The ARTP forum came into its own as a source of guidance and reassurance about the correct routines to follow in our departments. Many of the wise posts came from the ARTP COVID group who are to be applauded for identifying the most common questions and providing clear guidance both in emails and the forum but also via the website (https://www.artp.org.uk/COVID19). This issue contains a shortened 'Top Forum', which tries to reflect just some of the many posts since the last issue and there is also an illuminating article about how the ARTP COVID group came to be formed.

After a while, the topics on the forum turned towards "how do we resume testing?". I am grateful to several departments who contacted me with details about how they dealt with the situation as the crisis developed (see 'How did we cope?') and there were novel solutions to the question of how to get testing restarted; I wonder if 'Drive-thru spirometry' really is "the next direction to go in"?

Similarly, Matthew Rutter asked the manufacturers how they were coping and their answers are in a special "On the Blower" edition. Matt himself is in the group who needed to shield and he kindly provided an article describing "Worklife behind a shield". Anyone who knows Matt will be pleased to read that he remains "*a happy, healthy and positive person*" and I am grateful for his support in producing this issue.

Away from COVID-19, we have an update on UKAS accreditation and the IQIPS scheme introducing IQIPS Standard V.2. We also have the latest in 'How it works', this time featuring Kevin Hogben's view of the history and function of spirometers.

As ever, but particularly for this issue, my thanks go to all contributors and the reviewers of the Editorial committee. You may notice there is a 'position vacant' by Deputy Editor—so let me know if you are interested!

Aidan Laverty

Please contact the Editor, Inspire@artp.org.uk

A WORD FROM THE CHAIR

Julie Lloyd

ARTP Honorary Chair

Hello, and welcome to 'A Word from the Chair'. We find ourselves at that time of year when we would normally have been on our summer holiday, somewhere warm and faraway and we would return rested and relaxed. Many of us would also be making our final plans for attending the ERS Congress in Vienna. However, this is unlike any other year that we have experienced and normal is not a word that we seem to use any more.

Many of you are beginning to re-start your lung function and sleep services, albeit working in very different ways from how you have practiced before. For some of you, it feels that there has been little respite from the pressures of managing COVID-19 in its acute phase, to switching back to delivering services in the endemic stage. On a personal level, the transition from working on an in-patient ward with acutely unwell patients to working back in my department and trying to see how the lung function and sleep services could be delivered has been extremely challenging. However, the information on the ARTP Forum and the endless support of my excellent team has made the job much easier.

With that in mind, ARTP is developing a number of webinars to allow people to share their experiences of COVID at the various stages during the

pandemic. These will be available to ARTP members via the website and if you would like to contribute to this project, please get in touch with us via ARTP admin.

Despite the many challenges posed by COVID, ARTP has continued its work on a number of important projects. I was delighted to see the publication of the 'Statement on Pulmonary Function Testing 2020' in BMJ Open Respiratory Research. This update of the landmark BTS/ARTP Guidelines for the Measurement of Respiratory Function 1994 was long awaited, but certainly worth the wait. I would like to thank everyone who contributed to this excellent document, with particular credit to Dr Karl Sylvester and Mr Keith Butterfield for their patience, dedication and many, many late night Skype meetings!

ARTP have also been busy re-evaluating our educational courses and looking at ways that we can deliver teaching differently, but to the same high standards that we are known for. We have made great progress with the Spirometry Certificate programs and will be using a web-based platform for submission of our new e-portfolio. The ARTP Spirometry Register is now being hosted by the Academy of Healthcare Science and, in partnership with them, we will work towards Professional Standards Authority (PSA) accreditation of the Spirometry Register.

Given the problems with holding face-to-face events ARTP, supported by EBS, are working hard to develop new ways to deliver our professional meetings. The National Strategy Day will be a 'virtual' meeting and registration is open for this free to attend event. The event will be held over 2 half-days and the exciting programme includes sessions covering leadership in healthcare science during difficult times, an update on the Spirometry Certificate and an update on the national plan to improve lung health and its impact on diagnostics. It provides an opportunity for members who are often unable to attend this event to get involved and I really hope you enjoy this new and exciting format. ARTP have also taken the decision to hold the annual Conference as a virtual event, which promises a host of exciting topics and speakers – more details will follow soon.

On that positive note, all that is left is to wish you all a few more sunny days of summer and to look forward to the challenges that lie ahead.

Matt Rutter

Alan Moore

Prof. Brendan Cooper

ON THE BLOWER

This edition of 'On the blower' has the latest product updates from several of our manufacturers. We asked them if they could tell us about their experiences and some of the issues they have faced during the COVID-19 pandemic.

Manufacturers Survey

ARTP has decided to postpone the manufacturers survey this year due to many departments not testing for long periods and the manufacturers having to adapt how they operate. It would be difficult to assess with the metrics we use when the situation all round is far from business as usual.

If you do have any issues please contact your account manager, if you have unresolved issues please contact watchdog@artp.org.uk

MR

PRODUCT UPDATES AND NEWS:

CLICK ON MANUFACTURER LOGOS TO BE TAKEN TO THEIR WEBSITES

Circassia

Thinking of resuming your FeNO service? Circassia is here to support you.

The entire NIOX® team are available to support you during these challenging times. If you are thinking about resuming your FeNO service, we have produced a short FAQ that you may find informative.

Can I continue to use FeNO to manage my patients with asthma during this period?

It is recommended to maintain asthma control and continue to follow the individuals' Asthma Plan as this is especially critical during the pandemic of the respiratory disease COVID-19[1,2,3]; this includes the importance of FeNO testing.[4]

FeNO testing has not been classified as an aerosol generating procedure[5-8] and breathing

required to complete a test is done purely via the filtered mouthpiece of the NIOX device itself.[9]

How effective are NIOX VERO® patient filters?

The bacterial and viral filtration efficiencies of the disposable NIOX VERO® mouth filter are exceptionally high (>99.97%10). A microbe 4 times smaller than the size of SARS-CoV-2 (COVID-19 virus) was used to test the filters' efficiency to prevent this microbe from passing through the NIOX® filter.[10]

How should I clean and disinfect NIOX VERO®?

Alcohol containing disinfectants (such as ethanol and isopropyl alcohol) must not be used for cleaning the NIOX VERO® device or breathing handle, as this will affect both the performance and results generated.[9] That is why we recommend in regard to COVID-19 specifically[11-17]: **Sodium hypochlorite 0.5-0.65% and benzalkonium chloride 0.05-0.2% are effective cleaning agents against** SARS-CoV-2 (the coronavirus causing COVID-19), and can be used to clean the NIOX VERO® device itself.

If you would like more information or have further questions, please contact our Medical Affairs team at medical.information@circassia.com.

FeNO: Fractional Exhaled Nitric Oxide

References: 1. Moore 2020. 2. NCIRD 2020. 3. Asthma UK 2020. 4. Menzies-Gow 2019. 5. Hull 2020. 6. Public Health England 2020. 7. CDC 2020. 8. Tran 2012. 9. NIOX VERO User Manual 000191-13. 10. Circassia Ltd Data on file 2014-2020. 11. WHO 2020. 12. NEA 2020. 13. EPA 2020. 14. ECDC 2020. 15. Health Canada 2020. 16. Rabenau 2005. 17. Kampf 2020. The complete list of references can be found on our website (www.niox.com/en-gb/coronavirus-faq/).

Fisher & Paykel Healthcare

Fisher and Paykel Healthcare would like to say a huge thank you to all of the NHS staff for all their care and dedication during this hugely difficult period. Whether you were redeployed to help support the acute effort or trying to continue your service whilst working under difficult circumstances, the speed at which clinicians have adapted to this new way of working has been outstanding and we're hugely grateful to each and every one of you.

As the NHS has had to respond and change, F & P global had to react to the pandemic fairly promptly also. Following the initiation of our global crisis management plan at the end of January, manufacturing increased 4-fold. With approximately 1500 components required to make up each piece of hardware, our supply chain team had to ensure the flow of raw materials across closed boarders whilst the industries that supply these components were being shut down. With air freight reducing down to approximately 1% of its normal volume, there were a number of logistical problems for the supply chain team to solve.

At a more local level, our sales teams have been alternating between providing support in the hospital and volunteering in the warehouse to help deliver goods to those who need it as efficiently as possible.

Education continues to be of utmost importance to us and we will be here to support your services, providing tools for you and your patients to assist your new way of working. Our COVID-19 resource centre will also provide you with useful information that you may need to treat patients when using our products: https://www.fphcare.com/en-gb/covid-19/. If you would like any more information, please contact your local Territory Manager - they are available and happy to help!

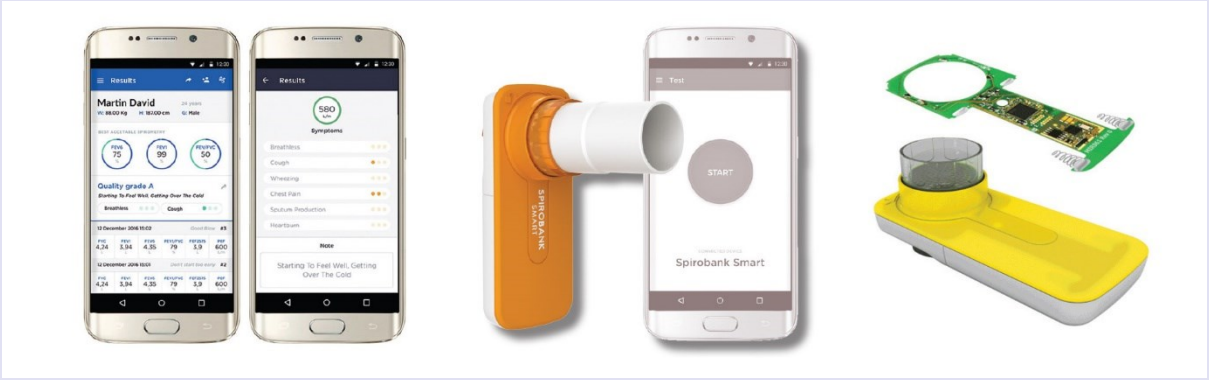
Intermedical

Crazy times at Intermedical since the beginning of the pandemic. As with many companies we were initially nervous as to how it would affect our business. But it soon became very apparent that we had a major role to play with the sourcing and supply of portable oxygen concentrators to NHS trusts concerned that they oxygen capacity might be breached during the peak of the virus. In a logistic nightmare, with components difficult to find, working extra hours and weekends and with vastly reduced shipping options, we were able to source an extremely reliable supply line. Coupled with help from a shipping company who allowed us to use their air shipping resources at cost price, we managed to distribute over 5000 concentrators and allowed many COVID wards and camp hospitals to be set up, releasing the pressure on the oxygen demand in hospitals during the peak of the pandemic.

The stresses involved for everyone were huge from the office staff processing the orders, the warehouse team packing and shipping thousands of devices and the sales team managing the allocation of available stock. It is nothing compared the dedication and

sacrifice of our NHS staff and key workers, it is our job and we enjoy what we do but we are extremely proud of what we managed to achieve and were looking forward to a bit of a break. But then it didn't end there……

With routine lung function testing coming to an abrupt halt we were being inundated with requests for a remote solution to help clinicians continue to monitor their patients. The Spirobank Smart is a low cost but extremely accurate spirometer that works via an App on the patient's Smartphone. The App is free of charge and there are no licence or subscription costs. The clinician makes a video call to help coach the patient through the test and the results are then sent directly to the clinician as a PDF. We are working on a number of improvements to the App and these will be released in the coming weeks. We have also been working with a number of portal providers allowing them to integrate the device.



And finally we are working on a number of projects with the Ndd EasyOne ProLab full PFT system for mobile and community full PFT. If the ARTP Covid guidelines are strictly followed, the ability to clean equipment rather than a whole room can speed patient throughput considerably. The ProLab requires minimal warm up time, is automatically calibrated and is fully portable.

Exciting times ahead!!

Koko PFT

Firstly, we hope that you are all safe and well.

A lot has changed since the last 'On the Blower' and not only with the COVID-19 global situation. As we mentioned in the previous edition, nSpire Health's Chapter 11 bankruptcy exit plan has been approved and implementing this has been taking full effect.

The company has been relaunched as KoKo and will be trading as a new company KoKo PFT Ltd in the UK. We have been through a restructuring and have an imminent relocation of our UK office to newly built facilities, still around the Hertfordshire area, as our base going forward.

Unfortunately, we have needed to finally call a day on the support of some legacy products including the CPL and ZAN. Due to the age of this equipment the parts have been increasingly difficult to obtain over the last few years and finally some are unavailable.

KoKo has been working closely with respiratory professionals to get the best advice and information possible. This enabled us to meet the difficult challenges COVID-19 has brought us as a company as well as to our employees and customers. Following this we have implemented changes which help to reduce the spread of infection and keep everyone safe.

During the COVID pandemic most of our staff were set-up for remote working. In addition, we have managed to keep a skeleton staff safely working at the office to dispatch products. Our production of respirometers has been seeing a great demand globally; after a week's break and careful planning we managed to safely keep our production running.

Most importantly we continue to be here to support you as best we can now and in the future. Please don't hesitate to get in touch with any of your needs.

David England

dengland@kokopft.com

07808 248484

PARI Medical Ltd

Improving Nebuliser Technique

The BTS Guidelines[1] detail the importance of correct inhaler technique, but did you know that correct **nebuliser technique** is also important?

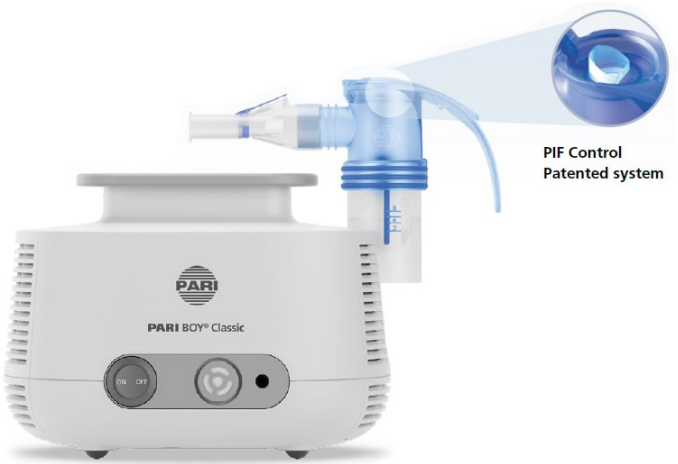
When medications are nebulised, the amount of drug reaching the lower airway can be greatly influenced by how quickly the patient inhales[2]. If inspiration is too rapid, medication is more likely to be deposited in the mouth, throat and upper airway, instead of reaching the target area - the 'respiratory zone' of the lower airway.

Breathing in quickly | Breathing in steadily

Introducing the *New* PARI BOY Classic Nebuliser System & PARI LC SPRINT Nebuliser with PIF-Control

In line with PARI's vision to offer innovative products for comprehensive respiratory care, the PARI LC SPRINT Nebuliser has been developed to include the **Peak Inspiratory Flow (PIF) Control System**. The principle of PIF-Control is to guide the patient to inhale their nebulised medication slowly and steadily, thereby improving deposition of the active agent in the lower airways.

If the patient inhales too quickly, they will feel a gentle resistance from the PIF-Control system in the upper section of the nebuliser, prompting them to inhale at a slower rate.



The new **PARI BOY Classic** Nebuliser System includes the LC SPRINT Nebuliser with **PIF-Control**

To request **a virtual demo** via Microsoft Teams video conferencing, email infouk@pari.eu or call 01932 341122

1. https://www.brit-thoracic.org.uk/btssign-british-guideline-on-the-management-of-asthma-2019/

2. Laube et al 1992, J Allergy Clin Immunol. 89(2): 510-8

PARI Medical Ltd, Unit 8 Oyster Park, 109 Chertsey Road, West Byfleet, Surrey KT14 7AX, Tel: 01932 341122 · www.pari.com

ON THE BLOWER

RemServe

A Supplier experience of dealing with Covid-19

Here at Remserve Medical our mission is uncomplicated; to reliably supply and meet the needs of our customers in terms of quality products, service made simple and consistent pricing.

During this pandemic, our main challenge and focus have been around maintaining stock levels; our usual processes were put to the test as unexpected order quantities hit hard during March and April.

We have needed to break from the norm and have stock flown in rather than shipped on the water which is our usual method to keep costs as low as possible, which is reflected in our pricing.

Our aim has been to keep our pricing as stable as possible during the pandemic wherever possible, and we succeeded, with the exception of just one or two lines, negotiating with suppliers and in some cases working hard to find quality alternatives when stocks ran low.

We have managed to keep our next working day delivery schedule on stocked items. We are extremely thankful and proud to have such an amazing team who voluntarily increased their weekly hours during this time to enable us to stay on track, even driving a hired van full of stock all the way to Scotland to get it where it needed to be as quickly as possible.

The pandemic has also given us food for thought in terms of future planning. We already have plans in motion to be pandemic-ready in future, including contingency stock of our usual range. Additionally, PPE will be held in our warehouse so that we can step in quickly with requests from our valued customers.

The desire to delight and exceed expectations runs through the core of our business, putting our customers at the heart of everything we do.

Christopher J Wingfield

Owner and Founder of Remserve Medical

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Company Reg: 8231922
Website: www.remservemedical.com

ResMed

On ResMed's Digital Healthcare Solutions and Supporting the NHS

While the COVID-19 pandemic has presented unprecedented challenges to the UK healthcare system, it has accentuated the strength and resilience of the entire NHS community. The NHS's swift transformation to manage this public-health crisis and adoption of digital tools to maintain continuity of care have been nothing short of remarkable.

The pandemic has also underscored the importance for med-tech companies to support healthcare providers throughout this period and with the return to a 'new normal'. Accordingly, ResMed is committed to helping the NHS in restoring sleep and respiratory services through innovative products and solutions.

Since the onset of the pandemic, ResMed has delivered prompt assistance to the UK Department of Health and Social Care to support their national response plan. Rapidly increasing its manufacturing of ventilators, masks, and accessories, and accelerating the launch of AirView™ for Ventilation, ResMed has helped the NHS meet increasing demand. ResMed's provision of training resources, technical expertise and data-enabled services has enabled clinicians to adopt digital care pathways where patients were assessed and treated remotely. Accessing detailed respiratory information from ResMed ventilators, namely *Astral*, *Stellar*, and *Lumis* devices, healthcare professionals were equipped with the products, knowledge, and technology to serve more patients whilst reducing hospital visits.

As we transition to the new state of normalcy, ResMed will uphold its commitment to support the NHS in its endeavours to reopen services and rebuild capacity. Treating OSA and COPD patients, healthcare professionals can now diagnose and set up new patients remotely through ResMed's sleep study and remote set-up services, and they can dispatch devices and consumables to patients' homes through our connected care services. They can also remotely monitor treatment efficacy by accessing patient data using our tele-monitoring solutions. Implementing digital healthcare pathways, the NHS can be assured of ResMed's support every step of the way.

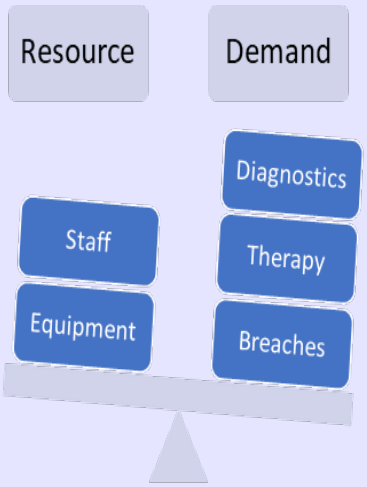
S-Med

S-Med launch new sleep diagnostics services

Even in the best of times there are challenges in delivering the top-class service your patients expect. Recent events have made those challenges even tougher, but there is still an expectation to deliver on time.

We have been asked many times if S-Med can support departments by providing a diagnostics service in addition to the SOMNOmedics range of devices. Many departments are working with one or more of the following challenges:

- Shortage of qualified staff
- No capital budget for additional equipment
- Not able to cover temporary resource problems
- Reluctance of patients to attend hospitals due to fears of COVID-19



We are very happy to announce the launch of our sleep diagnostic service. Recognising that different departments may suffer from different challenges, we offer a flexible, fully customisable solution to meet the challenge. We will work with you to reduce waiting lists, prevent breaches, and help you to deliver the first-class service you are aiming for.

Talk to us about your diagnostics pathway problems and we will offer a solution designed to address your specific challenges. We can quickly implement solutions to short term problems, such as getting through a backlog of unreported studies, or support during long term staff absence. We can also work with you to implement significantly different service delivery pathways that will improve the cost of delivering diagnostic services.

In addition to the above, we would also like to remind you that we carry a full range of disposable Effort Belts, SpO_2 probes, Nasal and Nasal/Oral Cannula, ECG, EEG, EOG and EMG Electrodes.

Contact us at enquiries@s-med.co.uk or by telephone on 0121 6550092 or visit our website https://s-med.co.uk for more information.

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

Vitalograph Makes Remote Patient Monitoring Easier Than Ever

Vitalograph has been working hard to support our customers across the UK and Ireland, as well as globally, during these uncertain and trying times. Whilst telehealth and telemonitoring have been around a long time, Covid19 has accelerated interest in remote monitoring and an urgent need to implement new ways of supporting patients remotely.

For over two decades, Vitalograph has been providing products and services for remote cardio-respiratory monitoring in clinical drug trials. We have extensive experience in supporting remote monitoring programmes for asthma, COPD, cystic fibrosis, ILD, sarcoidosis, post-transplant patients and other respiratory diseases in over 250 drug trials.

Our partners include '*Project Breathe*' led by the Cystic Fibrosis Trust with the Papworth CF centre and the CF Health Hub (CFHH). Kirsty Hill, Managing Director of Magic Bullet who have been conducting Project Breathe with the CF Trust said '*Vitalograph lung monitor is a great choice for home lung function monitoring. It is simple to set up and connect with seamless data capture, from a trusted brand in healthcare.*' For occupational health we work with the Occupational Asthma Expert system (OASYS) which is a free to use software for detecting work-related changes in peak flow readings using the asma-1 USB electronic monitor.

We offer a full range of telemonitoring solutions to suit any need or budget from the asma-1 non-comms device for FEV_1 and PEF, to the lung monitor BT SMART for FEV_1, FEV_6, ratio, etc. and the full feature micro spirometer BT SMART with flow-volume loops.

Vitalograph is the ideal partner for your remote patient telemonitoring solution. Visit https://vitalograph.co.uk/telehealth or call us on 01280 827110 for further details.

ARTP COVID-19 Group: A Story of Leadership in Adversity

What/Who is the ARTP COVID-19 Group?

You may remember back during the dark early days of the COVID-19 pandemic, in March 2020, when the scaremongering, genuine fears and misinformation about what turned out to be the devastating pandemic for our people and economy was flooding our conscious lives. Information and evidence/ guidance was pouring into our email accounts from government, public organisations, professional bodies, our Trusts and then we got even more on social media, the press, TV and radio as well as chit chat with colleagues and even the public. If COVID-19 was a war, truth, as expected was its first victim!

Why was the Group Formed?

The ARTP Forum, with just reason, erupted into a barrage of questions and discussions around what department's staff should do to manage COVID-19 in terms of operations, procedures, advice on providing oxygen and assisted ventilation, advice on infection protection and control……the list was almost endless. Having been a previous Chair & President of ARTP, I soon realised that we needed to take some sort of control of the situation regarding the ARTP Forum to (i) stop a panic reaction or hysteria spreading across the profession, (ii) to give balanced, correct and factual advice based on the evidence and (iii) to challenge others advice if we suspected its was based on poor evidence or just opinion.

COVID-19 Timeline

2019

Dec COVID Outbreak reported in Wuhan China

2020

31 Jan First **2 cases** COVID-19 in the UK are confirmed

27 Feb Now **13 cases** in the UK**.** **(Containment phase)**

29 Feb **1st British death** from COVID-19 (Japan, man quarantined on the *Diamond Princess* cruise ship.

5 Mar **1st UK death** from COVID-19 is confirmed. **No. Cases >100.** **(Delay phase)**

7 Mar **No. Cases >200**

14 Mar UK **death toll doubles** in one day from **11 to 21 deaths**

16 Mar PM advises all UK against "**non-essential" travel** and **social distancing**, **work from home.**

18 Mar **ARTP Covid19 Group established**

21 Mar **Health Protection Regs** (COVID19, Business Closure, England) 2020 (SI 327) come into legal effect.

23 Mar Prime Minister announces a UK-wide **partial lockdown:** ***"Stay at home. Protect the NHS. Save lives".***

25 Mar **1st two working NHS doctors die** from COVID-19, one a GP, the other a surgeon.

26 Mar UK COVID19 increases by more than **100 deaths in a day.** At 8pm, **1st "Clap for Carers"**

28 Mar **260 deaths** - now **1,019 deaths in total.**

29 Mar The **first NHS nurse dies** of COVID-19.

31 Mar No. people in hospital with COVID-19 passes **10,000.** UK daily death toll of **381 deaths total to 1,789**

6 Apr No. deaths from COVID-19 in the UK exceeds **5,000.** Total No. reported cases **= 52,000.**

11 Apr ITU Occupancy in England peaks at 58% of capacity.

14 Apr More than **16,000 deaths** in the UK

19 Apr No. deaths increases by 823 to **17,337 deaths**

22 Apr **"At the peak"**

I sent an email to the current ARTP Chair and President on 16th March offering my advice that I believed we need to form a "backroom Forum" that was limited to a small group of respiratory experts (see Table) to be able to argue the issues around advice or guidance in a closed group.

"……forming a small ARTP COVID19 Forum on-line with leading lights from ARTP in NIV, Oxygen and CPAP and related issues. This would give us a specialist forum to share knowledge experience and best practice as things develop and to argue/ discuss strategy in a safe environment before the Main ARTP Forum. Information from this Forum could then form guidance to go to the main ARTP Forum to support staff on the ground. Our LF leaders will need support in a very stressful time given the professional and personal pressures which they maybe have not experienced before."

The idea was to rapidly reach a consensus on the advice ARTP should deliver to the profession in the absence of any other specific advice from government, or other professional organisations. In effect, there was an information vacuum that could rapidly be filled with misinformation, conjecture and random opinion. The group needed to consist of the ARTP Chair and President, together with senior experts in acute and home NIV, ventilators, home oxygen, paediatric issues, and infection control to start with. The idea was to have a mix of intensivists, respiratory physicians, clinical physiologists/ scientists and experts in a range of physiological services.

Immediately, Julie Lloyd and Jim Hull backed the idea and gathered the small crew of key people to help form the Group. All immediately agreed to help and contribute without hesitation, although some of the intensivists had to warn of their other commitments on ICU – not surprisingly! Within 2 days, (18th March) the COVID-19 Forum was set up and running by ARTP Administration (brilliant work by Phil Baker and Kerri Smith at EBS!). It could accept direct emails within the group and "abridged emails" from the main ARTP Forum for the group to answer collectively before posting a response back on the main ARTP Forum.

On 23rd March the first email was received from Parisa Rafizadeh-Farahani asking about PPE for CPAP & NIV Set-ups. Whilst the Group anticipated some of what was required, very often the membership would pre-empt our planned documents and advice. Clearly we were on the right wavelength and fulfilling the needs of the membership.

How did ARTP COVID-19 Work?

The Group had the following functions;

⇒ Producing consensus evidence based on expert opinion on questions raised by ARTP members posted on the ARTP Forum.

⇒ Review, discuss, edit or draft documents to advise NHSE/I, BTS or RCP regarding COVID-19 and respiratory physiology issues.

⇒ Prepare and edit advice about clinical physiology information useful to ARTP and other respiratory medicine users of lung function, etc.

⇒ Drafting, revising and editing papers for publications around COVID-19 related issues.

⇒ To collate evidence from ARTP members about trials and experiments done in a scientific manner (e.g. FiO_2 in CPAP circuits)

The prime directive was to focus on the **respiratory physiology** issues mainly. The medicine, intensive care and nursing and other issues have amply been covered by others (BTS, RCP, PHE, RCN, etc.) during the pandemic. ARTP was seen nationally (and beyond) to be the leading group for delivering rapid accurate respiratory physiology advice during the COVID-19 pandemic.

Typically, a question would come in via the ARTP Forum. It would be agreed to either (i) offer a simple answer referring to previous guidance or (ii) to discuss it amongst the COVID-19 Group. This could involve a few days of searching for evidence, publications and data. A draft guidance document would be generated and discussed within the group on email. Once a consensus final document was agreed, the ARTP Chair would instruct ARTP Admin to distribute on the final approved version. This way, there was control over versions, content and timing of any guidance.

One of the reasons that this could be done at pace was because several of the team were self-isolating at home and were able to commit long hours into searching for the evidence and reviewing the drafts. Furthermore, some clinical members where changed to 12 hour day and night shifts where long hours of uninterrupted periods of concentration were possible. (One of the joys of a 12 hour night shift is clearing your email box, going up to the ward for a few hours clinical work, then returning to your PC to find no new emails – at 3 o'clock in the morning!). Sometimes responses were a one-liner "…looks good to me!" and others would be pages of narrative and discussion. All of it was helpful in shaping the guidance and keeping the momentum going.

What has ARTP COVID-19 Group achieved?

The Group has produced much guidance in a short amount of time covering a range of issues relevant to ARTP members and their teams across the UK (See list below).

ARTP actually received several messages from consultant physicians thanking us for the data on FiO_2 and entrained oxygen, because in some regional hospitals where ICU was at capacity they were able to deliver CPAP and oxygen on the wards saving many lives and reducing bed stays. This feedback was very rewarding and drove us on to help our respiratory clinical colleagues further.

The work from this group is also recognised in the updated BTS home ventilation submission. Indeed the "special relationship" built between ARTP and BTS have been strengthened with "dual-badged ARTP/BTS documents" and BTS members being able to access the ARTP Forum during the pandemic.

We have also tackled controversial areas such and AGPs and PPE for lung function testing and the raging arguments as to whether the risks of lung function testing was similar to AGPs and whether staff and patients should be protected from cross-infection. This generated at least 3 different versions of guidance, but I think we can safely say that there is insufficient high quality evidence to prove beyond reasonable doubt that full PPE isn't required. On the balance of probabilities, ARTP has erred on the side of caution to protect staff and patients. There is no shame in that – we've seen patients being tubed and bagged as they're taken down to ICU for 30 days! COVID-19 has been a brutal infection that has taken at least 42,000 UK lives – so far.

The Group have learned and utilised some important lessons that epitomise the scientific approach to problems. We have been looking at literature outside of what we normally look at and adapting and integrating that literature in relation to what we all do every day. Broadening our knowledge into other spheres (including aerosols!) of work has been both challenging and illuminating. Many ARTP members have had to re-purpose their jobs and roles in the pandemic, whereas we have also had to "re-purpose" our physiological minds to be virologists, epidemiologists, physicists and humanitarians.

"A man goes to knowledge as he goes to war: wide-awake, with fear, with respect, and with absolute assurance. Going to knowledge or going to war in any other manner is a mistake, and whoever makes it might never live to regret it". — Carlos Castaneda, The Teachings of Don Juan: A Yaqui Way of Knowledge.

List of ARTP COVID-19 Guidance (*see ARTP Website*)

ARTP Guidance - Respiratory Function Testing and Sleep Services During Endemic COVID-19

Restoring Lung Function Testing for Management of ILD Guidance - ARTP/BTS

ARTP Guidance for Oxygen Utilisation

ARTP Long Term Oxygen Assessments and Reviews during Endemic COVID-19

ARTP COVID19 Infection Control Issues for Lung Function

ARTP Data on CPAP and Entrained Oxygen

ARTP Pulse Oximetry Guidance for Community Practice

ARTP Suggested Lung Function Testing after COVID19, pneumonia or ARDS

ARTP Guidance on CPAP and NIV in the Community during COVID19

ARTP Black, Asian, Minority Ethnic (BAME) Statement

Supply of Non-Vented Full Face Masks

What have we learned on the journey?

At the beginning of April we realised that the main ARTP Forum was becoming too draining and challenging often with peoples' opinion rather that accurate reliable fact. On the one hand it was good that people (i) shared information and insight, (ii) criticised potential guidance constructively, (iii) described what was happening on the ground and (iv) let off steam about their experiences during a very stressful time.

However, we also realised that (i) people couldn't actually absorb all the information being offered, (ii) it raised doubts, fears and anxieties about their own services and abilities and (iii) it could undermine recommendations and local strategies.

At one point we considered to either heavily edit all ARTP Forum content or to only allow normal levels of openness and even the possibility of shutting the ARTP Forum down to preserve workforce morale and reduce general levels of anxiety. We finally agreed to have a process of submitting questions to the COVID-19 Group –and this calmed things down a lot.

I think ARTP Forum members need to learn from this experience and consider what they are asking, how they ask it and how they respond others. In a national crisis such as a pandemic, there is a danger of making things worse by stoically fighting your ground for the sake of winning the argument rather than accepting alternative opinions. Also, the ARTP COVID-19 Group were themselves clinical physiologists struggling to deliver their own services during a very difficult time.

We have learned much about infection protection and control knowledge, methodology and operations, but the reality is that their method of evidence collection and opinion is not usually the same as we're used to in respiratory physiology. There are few randomised controlled trials since they are ethically difficult to design and deliver. There is much supposition, extrapolation and interpretation by experts and sometimes these can be controversial or plain wrong. However, we must respect their experience and knowledge, build bridges and connect with the IPC community at to develop the answers to our questions in as scientific a way as possible.

What could have been done better?

You always learn by reflecting on work you have done. This Group was devised created and delivered within days as the COVID-19 pandemic raged around us. What we knew then was a fraction of what we understand now – and we still have plenty to learn. If we were to be critical we probably should;

i) have included a patient representative(s)

ii) could have involved more members from outside the West Midlands

iii) managed to get paediatric physiologists involved

iv) linked with infection control teams more

v) worked with a respiratory epidemiologist

However, the proof of the pudding should come from the ARTP membership, who I have to say have been very generous in thanking the Group for the work we've done so far. I'm sure others will come forward in the future. ARTP Forum may wish to keep a "specialist advisory group" beyond COVID-19 to help solve questions on the Forum and inform areas of clinical guidance in the future.

Leadership

As a leader, I have learned so much from the ARTP COVID-19 Group. I have over decades had a reputation for being fairly critical and outspoken on the ARTP Forum. (OK, what do you expect from a gobby Scouser!). However, what I have learned was that giving away knowledge or pieces of work for the common good freely, arguing constructively but not making things personal, supporting and praising colleagues contributions, being respectful and kind has created more success than years of trying to always "lead from the front". Being a leader should not mean that you know best, or that your opinion is actually the right one. Leadership here was around herding the ideas, shaping the consensus, maintaining a momentum and trying to keep everyone on board. As time has gone on, the members of this group have learned to trust and respect each other's opinions. We have acknowledged each other contributions, strengths and realised our own weaknesses or areas of ignorance.

Personally, I've learned that the best way to lead my colleagues in a crisis is to give away my expertise, share my experience, express my ideas and understanding of subject expertise, and express my honest opinion without ownership, the need for recognition or any petty jealousy about who contributed what. Empowering others to contribute and encouraging them to take a lead is a very powerful tool to help deliver such important guidance collectively.

All members of this Group have been amazing, but three members of the group have particularly stood out for me. Firstly, Alan Moore, (who is supposed to be retired and taking life a bit easier!), has been a workhorse at using his every contacts and links to get information quickly about a lot of technical issues. Secondly, Adrian Kendrick has locked himself in his basement study for days on end and written

reams on infection control, aerosols, body temperature and much more besides. Finally, Martin Allen, our consultant physician from UHNS, who is also the national respiratory lead for GIRFT, has been amazing at feeding ARTP information to NHSE/I, the BTS and RCP as well as ensuring ARTP expertise is included at the highest level. All these contributions have been above and beyond the call of duty, and often during personal time. We should also thank their families for their patience and support too!

The ARTP COVID-19 Group has been an example of the best that respiratory healthcare science professionals can deliver as a team. We are pleased to have supported the membership, and I hope we have set an example to younger ARTP members in the future to carry on similar work. Professional responsibility isn't always asked for, it is having the insight to see a gap, anticipate a need or just taking a lead because you feel it is important and you want to make a difference.

I have by and large enjoyed and benefitted greatly from working with a great bunch of like-minded professionals, who also, have great sense of humour. When things got tough, we could always find time for some fun, observational comedy or a joke. I would like to thank every member of the team for being so selflessly supportive and professional. It's been an honour to work with you all.

Whilst this article summarises the "end of the beginning" of the COVID-19 pandemic, we need to remember that the epidemic is not over yet and this may all be just the first surge of many. The ARTP COVID-19 Group will not be disappearing any time soon.

Of course, this article will now be submitted to the ARTP COVID-19 Group for comments, edits, errors, omissions and suggestions. The paper is open for discussion team!

Prof Brendan G Cooper on behalf of ARTP COVID-19 Group

ARTP COVID-19 Group & Contributors *(alphabetical by first name)*

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Alan Moore, Director, GlenAlexander, Vice-Chair, ARTP Sleep.

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Trefor Watts, retired Head of Physiology Services, Walsall Manor Hospital.

Dr Victoria Cooper, Consultant Clinical Scientist, Salford Royal NHS Trust.

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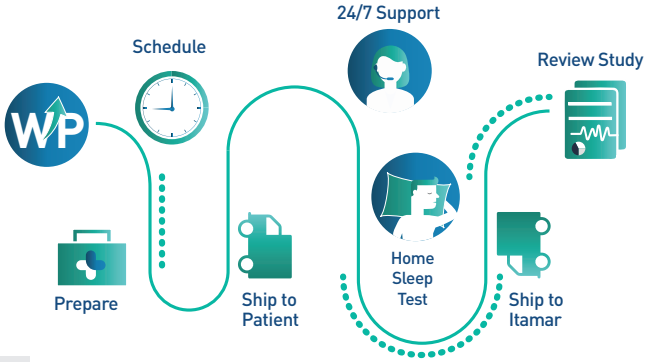

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How did we cope?

The previous pages outlined how the ARTP COVID19 group produced guidelines which we were all grateful for.

Overleaf are stories from individual departments about how they dealt with changing circumstances.

"However, [the crisis] has also triggered some amazing responses in all our healthcare staff and systems, and produced some wonderful examples of innovation, teamwork, redeployment, re-skilling and an outpouring of cooperation and support for all in the NHS. "

Prof Brendan G Cooper, AHCS VOX newsletter April 2020

https://www.ahcs.ac.uk/news-events/vox-healthcare-science-newsletter/

Cardiff Sleep Physiology team introduce new drive through sleep apnoea clinic

A team of Respiratory and Sleep Physiologists at Cardiff and Vale Health board have speedily introduced an innovative drive through sleep apnoea clinic in response to the challenge of servicing ongoing healthcare needs in the midst of the Covid-19 outbreak.

The team usually run an outpatient service within the Lung Function and Sleep Apnoea Department based at University Hospital Llandough, Cardiff.

However, when the pandemic entered crisis stage, all team members were pulled from their roles to train the Clinical Staff of COVID-19 wards in Continuous Positive Airway Pressure (CPAP) therapy. CPAP devices are non-invasive ventilators and are the most commonly used treatment options for people experiencing sleep related breathing problems. The treatment is commonly prescribed to address Obstructive Sleep Apnoea (OSA) – a condition where breathing starts and stops during sleep.

As the demand for COVID-19 CPAP on the wards reduced in the Cardiff and Vale locality, the health board attempted to re-introduce outpatient services in a safe way for both patient and Physiologist. Therefore, the team pioneered the idea of a 'Drive-In' Zone for outpatients who are on the waiting list for a Sleep Apnoea Test and CPAP Treatment. This involved telephone appointments followed a drive through clinic for Sleep Diagnostics and CPAP Therapy initiation for patients diagnosed with OSA.

As of 1st May 2020, there were 1003 patients on the waiting list for Sleep Apnoea Diagnostics and a further 77 waiting for CPAP Therapy initiation and the service was halted due to only urgent cases being seen in outpatients during the COVID-19 pandemic. There was a projected waiting list of 48 weeks, which would only increase due to the closure of the service to new non-urgent patients. Within the first week, the small team of Respiratory and Sleep Physiologists (4.0 WTE) had carried out 159 telephone consultations and 71 new patients had been seen within the drive-in area to collect their equipment. After a short trial phase, a second drive-in bay was secured to enable us to increase capacity. The feedback has

been overwhelmingly positive; many commenting that they were expecting to wait upwards of a year following the pandemic. As of 1st July 2020, the service has completed a mega 774 telephone consultations. The breakdown is as follows:

Sleep Diagnostics

621/1070 new patients have completed a sleep study (overnight oximetry or multi-channel sleep study) following a telephone consultation with a Senior Physiologist, followed by collection of equipment in the drive-in zone. (Increase in waiting list from 1003 to 1070 following referrals received). Of the remaining 449 patients, 139 patients did not want to proceed with a sleep study and 177 have been sent an invitation to book an appointment and we are awaiting their response. Thus leaving only 133 patients we are yet to make contact with.

CPAP Initiation

153 of 173 new patients have been set up on CPAP therapy following an explanation of their sleep study results and explanation of CPAP during a telephone consultation with a Senior Physiologist, followed by collection of their mask and CPAP machine in the drive-in zone. (Increase in waiting list from 77 to 173 following positive sleep study results). Of the remaining 20 patients, 7 have declined treatment initiation and 13 have been sent an invitation to book an appointment and we are awaiting their response.

"We feel really proud of the team and pleased that this innovative solution was introduced so quickly and smoothly to ensure patient care of the highest quality can continue to be delivered during these uncertain times."

Lois Attewell, Clinical Lead (Respiratory and Sleep) and Hannah Hunt, Unit Manager.

The Respiratory Physiology team at Southmead Hospital Bristol, like all departments, have had challenges with Covid 19 over the last very busy 100 days.

I have been so proud how my team have responded to the challenges we have all faced.

We have managed to keep our service running, performing diagnostic tests on our Lung Cancer and Urgent Patients.

We have also worked as Critical Care Support Workers for a month throughout the pandemic on our large Intensive Care Unit.

Our team were also involved in setting up the Bristol Nightingale Hospital.

Physiologists were also involved in Mask Fit testing as when the Physiologists went up for a test it wasn't being run in a very scientific way !

We are now running a trial looking at Home monitoring for Spirometry and virtual consultations with patients.

The Physiology Team have been inspirational to each other and other staff members and have dealt with many different challenges through the pandemic.

Jason Viner

Head of Physiology

Paediatrics at Great Ormond Street Hospital

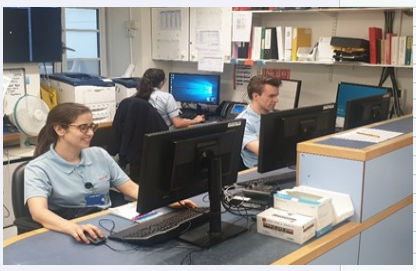
The Lung Function Service and our Clinical Physiologist role has been significantly impacted by the COVID-19 pandemic. For the safety of our patients and team members, routine testing has been suspended and only tests deemed urgent or clinically essential for decision-making have been performed. Physiologists have worn full PPE for testing which means a considerable amount of physiologist time is being dedicated to PPE training, fit-testing, donning, doffing and of course, washing hands!

After initial uncertainty over the role Physiologists could provide, the Lung Function team applied to volunteer at the Nightingale Hospital following a call for Respiratory Physiologists with specialist, transferable skills. The team attended upskilling sessions, to assist on wards if required; we shadowed nursing staff on Leopard and Kangaroo wards, contributing where we could. The pandemic has prompted healthcare providers to accelerate the use of telemedicine. We are pleased to be involved in establishing a pilot home spirometry service for our cystic fibrosis patients who are shielding. Patients will be able to use a portable spirometer, under the remote guidance of a physiologist, to conduct a basic Lung Function test from home, thus reducing the risk to physiologist, patient and family.

Ben Griffiths
Clinical Physiologist

The sleep physiologist team...

...have participated in the Trusts response to COVID-19 by shadowing on the respiratory wards and training nursing staff on the use of Non-invasive Ventilation (NIV) while continuing to maintain the sleep service, although at a lower patient capacity. We have developed new protocols to adhere to government guidelines.



The Clinical Physiologists have always closely worked with the Clinical Nurse Specialists in NIV and they have stepped-up in their running of the NIV service to allow the CNS staff to relocate to where required during this busy time. Duties included leading on parent competency training, assisting in medical reviews and helping with community NIV issues. We have also been involved in education. As part of the trusts upskilling programme the sleep physiologists have been running refresher sessions on Non–Invasive Ventilation for staff.

The sleep team is closely linked with the acute respiratory wards. In preparation for redeployment the team worked shadow shifts on Kangaroo and Leopard wards alongside the nurses and HCAs to develop new skills. The physiologists were happily received by the nursing staff who reported to a fantastic job which received praise on the Leopard Ward team shout-out.

The Sleep Team! Thank you to each and every one of you that has come down to support the ward nurses and patients. We love having you guys on the ward to help us, especially changing the babies nappies!!

Ansel Godinho
Senior Clinical Physiologist

During the pandemic we held a virtual ARTP regional network meeting in the East of England. We had a fairly productive discussion, collected survey data and considered how we would move forward. See the table below, which I hope captures where we were in the midst of the crisis. We are holding monthly virtual meetings and the feedback is that departments are finding these so helpful that others, from outside of the region, are joining (and are welcome!). We have also set up a virtual journal club, again this has received positive feedback.

Katrina E. Oates | Principal Clinical Physiologist | Lead for Physiological Sciences, Health Education East of England | Senior Lecturer, Anglia Ruskin University.

Royal Papworth Hospital NHS Foundation Trust

Time	What's the Question	Discussion Point	What we want to establish
11:00	Getting Settled		
11:05	Introduction to the session Welcome and mute Representations from across the region Mute Microphones Chat Recording meeting Surveys		
11:15	What has been happening in the region?	Responses from 8 Trusts representing a total of 55 staff. We have a range of activities including continuation of some tests, redeployment and focus on research or protocol review etc	New submissions of workforce survey
11:30	ERS Guidelines	Do people agree? Are people following them? If not why not? AGP	Are people following guidelines? What is stopping them?
12:00	The Future of Lung Function		AGP paper Suggestions for innovative services Case Studies Who do we need to talk to make things happen?
12:25	The future of regional meetings		Monthly MS Teams Meeting Education Opportunity e.g. CPET forum STP Equivalence support

I was asked recently to provide bullet points on this topic for IQIPS/UKAS as they may be required to make temporary or possible permanent changes to their standards for accreditation following COVID. Please see below.
Pete Moxon. Chief Respiratory Physiologist | Service Manager | Chair ARTP Standards Committee

1. **Impact of corona-virus on respiratory/sleep services**

- Cancellation of all elective, non-urgent work. Lung function and CPET testing on urgent pre-op and cancer patients as well as in some centres new ILD or those ILD patients being considered for anti-fibrotic medication
- New LTOT assessments only – limit patient footfall, typically some patients on home O2 will be shielding
- Use of PPE, in some centres this has been limited based on supply, therefore testing has had to be sessional to reduce overall use of PPE. Typically this was a lack of gowns
- Staff redeployment – onto ITU, acute wards, bed making, non-clinical volunteers
- Physiologists were designated to support high flow oxygen, acute NIV and CPAP in acute settings
- 7 day working, 12 hour shifts
- Some labs had or having dispute about whether lung function testing is an aerosol generating procedure/AGP (not officially listed in PHE guidance), in most centres IP have agreed on the cough inducing , AG nature of LFTs
- Significant reduction in face to face visits/consultations, reduce patient footfall into centres/labs
- Use of video and telephone conferencing for consultations
- Pre visit symptom questionnaires on patients, temp checks on arrival. Debate about what temp threshold should be used. PHE guidance currently state ≥37.8 as the marker for fever. WHO, ARTP and BTS guidance state that the threshold for fever is ≥37.3 and that this should be used to determine if we send patients away and to self-isolate
- Limits to manufacturer, service engineer visits to urgent repair only, no sales visits or sales reps
- Most labs struggling to maintain lung function activity – due to ventilation in testing rooms. Typically most hospital rooms should have a minimum of 6 air changes per hour which equates to 1 hour between patients to allow for aerosol deposition and subsequent cleaning. In rooms with 10 ACH=45 mins between use. Seriously impacts on number of tests we can do each day
- Staff Stress, concerns about redeployment, putting themselves at risk – frontline staff, increase sickness, need to self-isolate. Some staff required to shield and have not been at work since lockdown began. Reduced staffing levels
- Observing social distancing when at work

Plans for service reconfiguration

- Some services adopted a collection/drop off service outside the lab for sleep diagnostics, CPAP/NIV consumables etc
- In terms of reconfiguration an important point is the possibility of services adopting extended days and weekend work depending on how many tests can be done per day
- Reduction in face to face consultations, increase in use of telephone and video consultations
- Use of remote monitoring for CPAP/NIV reviews
- CPAP issue – not switching device on during issue- thus not classed as an AGP
- Use of Bluetooth spirometers – testing at home using phone app
- Use of team-viewer to enable remote spirometry testing- physiologist not in same room as patient, IT solutions
- Individual staff risk assessments to protect staff, in particular those from BAME, >40yrs old and males
- Trusts have released guidance on social distancing, ensuring staff can return back to work into safe environment- aimed at those who have been shielding
- All staff now to wear a surgical face mask when working in both clinical and non-clinical environments, patients to wear cloth/material masks
- Designated AGP areas identified in hospitals. In particular in endoscopy and lung function labs
- LTOT services have increased community assessments (if community service available for HOSaR), ambulatory assessments in the home , activity based rather than assessed via a walk test; portable blood gas analysers
- Some services in Leicester are investigating drive-thru spirometry – possibly to remove ACH and full PPE requirement
- Some hospitals are now insisting patients attending the hospital have a negative swab 48 hrs prior to attendance;
- Limits to patient footfall into hospitals

As we move into the restoration or endemic phase for respiratory services, there are considerable problems for respiratory physiology as there is a “perfect storm” of:

- All existing routine PFT and spirometry tests have been postponed since ~23rd March 2020 and have not yet recommenced in most trusts
- There is now a considerable backlog of patients which require reallocation of their outstanding diagnostic test
- There is a backlog of cancelled/postponed non-PFT diagnostics and therapeutics caused by re-purposing of lung function and sleep services during the crisis
- There will be a significant increase in respiratory physiology workload required for the follow up post COVID-19 patients who report acute respiratory symptoms, early/mid and long term respiratory complications of COVID-19 pneumonia are identified, patients with potentially life limiting complications of COVID-19 and identified and managed expediently, patients diagnosed with COVID-19 pneumonia who have to be appropriately reassured that physiological deficit has resolved, patients with undiagnosed pre-existing respiratory disease are opportunistically identified and managed
- As lung function testing has been designated as an aerosol generating procedure (AGP), lung function testing is limited by the air changes per hour in the testing area. At present the Infection Prevention teams are instructing services to leave 1 hour between testing for testing rooms with 6 air changes per hour. This adds barriers to the number of patients we can test on a single piece of equipment
- There is an identified national shortage of Respiratory Physiologists within the UK which results in recruitment and retention of staff being a real and current issue. One which may delay service provision and increases in waiting times.

Drive-thru Spirometry

Introduction

Workplaces are struggling to carry out testing to the same capacity as they did pre-COVID, or even perform it at all, so we have to think outside of the box. We were given the opportunity to hold out-patient clinics close to the Birmingham Nightingale at a cold site with plenty of space for distancing, but the availability was short term. We decided to use this space to test patients who had been shielding and therefore could not attend a hospital setting. The patients attending required Forced Vital Capacity (FVC) monitoring to determine if they were eligible for certain treatments, but aerosol generating procedures were not allowed in the building. We were given 3 weeks notice and had to make it happen. The only real solution: **drive-thru spirometry**.

Yasmin Khan in action

the next direction to go in?

Dr Vicky Moore, Clinical Scientist, Birmingham Heartlands Hospital

Methods and Testing

Initially the thought was to perform spirometry with the car window up to contain any aerosol. We tested this with several available meters in the staff car park near a generator (for extra noise pollution). It was a particularly warm day and it became clear that it would be very warm performing the testing in direct sunlight (which then brought in further issues of the air temperature in the car being raised and the spirometer being calibrated at a different temperature). However, it was possible. The window was down for the initial pre-test questions, contraindications and instructions. The window went up when performing the test. Although it was possible to hear through the closed window, communication needed to be kept to a minimum to avoid things being misheard. We concluded that we could get good quality spirometry through this method, but we could also have borrowed the techniques from a COVID-19 swab station, where staff ask you to call a number on the phone to take instruction. During writing of the SOP, our infection control department requested that we perform the test with the window down but in full PPE so as to be able to help the patient if they were in difficulty. This changed the usage of different spirometers. Table 1 shows the spirometers we tried along with the pros and cons. This list is of course not exhaustive and if we had plenty of time, we may have searched other available options.

Considerations

Performing spirometry in the car is not an ideal situation; there are many things to consider which will depend on where you are trying to perform it. For us, it was on another site. We had to do the following:

1) Write the SOP
2) Get the SOP checked by infection control
3) Rewrite the SOP
4) Send the SOP to management for consideration and sign off (allow time)
5) Send SOP to controlled documents for checking
6) Speak to the site managers to see if we are able to perform in-car spirometry anywhere on site
7) Consider where the staff parking is compared to where the in-car spirometry will occur, as equipment will need to be transported
8) Is a trolley available on site?
9) Is a canopy available, if not, a large umbrella?
10) Is there a place to don/doff and keep equipment/sit between patients?
11) Is there emergency help should you need it?
12) What do we need to tell the patients so that they come to the right place (e.g. signage, person on the gate , Other considerations)?
13) Ensure enough supplies of PPE, wipes, alcohol gel, mouthpieces, nose pegs, etc are taken to the site
14) Take 2 spirometers in case one fails when working off site
15) Have information about your patients ready so you know who is coming
16) How best to measure height: Portable stadiometer or predicted height from ulna length, arm span or demi-span
17) Make sure things can't fly away in the wind
18) Do we need a privacy screen?
19) How will the results get to the consultant?
20) This is ok in summer, but what about winter?
21) Only those coming in their own car or with someone they live would be eligible under current guidance – what can we offer to non-drivers?

Meter	Pros	Cons
Spirobank Smart	Able to Bluetooth to testers phone (ideally a work phone!) Patient can sit forwards and show phone screen to tester or tester can see their own screen on the outside of the car Single patient use turbines or reusable ones Can use bacterial/viral filter Can add pdf to electronic patient record when back on site	App at the time had limited quality feedback May need patient to download the app to their phone (in advance) IG consideration if using testers phone and for sending the pdf report App only stores one person (can have multiple sessions), so report needs to be sent immediately after for results Would need to instruct patient to press buttons if using own phone
Easyone air	End of test beeping for patient Has quality feedback and screen showing flow-volume loop Can be downloaded to a PC and report uploaded No parts to disinfect, just wipe the meter. Can download the results then upload to electronic record when back on site	Need the patient to twist towards the window to be able to see the screen while blowing. If no wifi or dongle would need printer available at site if report required immediately Limited availability of bacterial/viral filter addition to spirette (square shape) Would need to instruct patient to press
Easy-on PC	Patient can sit forwards as screen is on the outside of the car Has quality feedback and screen showing flow-volume loop Can use bacterial/viral filter on the end of the spirette (round shape) No parts to disinfect, just wipe the handle. Can upload results to electronic record when back on site	If testing with the window up, meter has a wire, so would need to be careful If no wifi or dongle would need printer available at site if report required immediately Needs a laptop/tablet so more cumbersome
Microlab	Has quality feedback and screen showing flow-volume loop Unit has printer for instant results Patient can sit forwards and show screen to tester if testing inside End of test beep for patient if unit inside Can use bacterial/viral filter Can download results then upload to electronic record back on site	If having unit on the outside, with window up, meter has a wire, so would need to be careful Would need to instruct patient to press buttons if unit inside Possible issues with turbine if windy

Table 1. Pros and cons of different meters tested for in-car spirometry

The reality

It worked well once we had the set up a little more streamlined – a trolley with the spirometer, clinical waste bag and patient equipment and wipes, plus a small fixed canopy to pop a chair and the trolley under between patients. We had to phone the patients to instruct them to tell the person on the gate they needed a breathing test so they would be directed to the correct place. If working more in advance, this instruction could be added to the letter. Patients are happy to perform the spirometry; there is enough room and it works well so long as they don't arrive by taxi, or arrive with a friend instead of the people they share a home with (or if they live alone).

Technically, because of the lack of wifi/dongle we have had issues with printing (we give the print-out to the patient to take to the appointment following immediately after the test). We have had a frozen screen, difficulties zeroing the turbine in the wind, but these have all been overcome easily. On our first session it rained, so the large umbrella was very helpful.

What would we do differently?

If this was a longer-term arrangement a portakabin would be very useful to don and doff PPE, store equipment, potentially measure height and weight, etc. before performing the spirometry in the car. We are exploring the possibility of this at another site that has ventilation issues and I believe other Trusts are too. A canopy (with open sides for ventilation) would be ideal but was unavailable for our short-term arrangement. Does it have to be in the car? Possibly not. You could have a chair out under the canopy although some of the issues such as wind and privacy need further consideration. Also in winter, if the temperature falls below a certain amount (16˚C for many meters), the meter may not function and the patient is not going to be comfortable. Having the meter inside the car with the engine running for warmth could be the answer here, but this would need further testing.

Conclusions

Drive-thru spirometry can definitely be useful and may be the difference between a patient getting access to treatment or not. There are considerations to be made for the set-up and the continuation of such a service which are relative to where you are trying to do it and what is available at that site. What have I learnt? Thinking outside the box is useful, but sometimes it's better not to have a box at all!

Worklife behind a shield

Matthew Rutter

I am a happy, healthy and positive person, I would not consider myself anxious. However, the prospect of the pandemic being on our doorstep had me feeling very anxious and nervous. Despite my good health, I do live with a severe lung condition and this puts me in the vulnerable group needing to shield. The decision was taken quickly that I would be better working from home as this would be the safest thing for my health.

I am lucky that I actually had the documentation for IQIPS to work through, which we have not previously been able to get our teeth into. The first few weeks went quickly; I was making great strides. I was also very aware of what was going on in the NHS and the amazing work that was being done by colleagues across the country. This is where the sense of guilt begun to set in. I was sat at home safe and colleagues were doing all they could and putting themselves at risk. I felt although I was working, I was not contributing to the effort. I felt separated from my great team and not doing the work that I was trained to do. The clapping started to happen, initially I happily joined in for the NHS but as time went on although I am NHS, I did not feel deserving of these claps. I just felt further separated from my work.

There had been plenty of highlights too, colleagues, friends and neighbours were helping me get my food. My commute was now 10 steps and I was having more contact socially than before lockdown! Not being able to leave my flat was an issue for exercise, my first 2 weeks averaged 200-300 steps a day. I had to start doing laps of the flat, 30 laps were about 1000 steps and took about 10 minutes, this wasn't sustainable! I managed to get an indoor

turbo trainer and have been cycling indoors regularly. I have even joined a group ride with colleagues from across the country. I have also taken a single day off a week to help break up the constant work.

As time has progressed the realisation of how long this could go on for was beginning to dawn on me. I had a mental wobble one morning at around 6 weeks, I spoke to family and was soon back to my positive self. I was lucky, I felt safe and comfortable at home and was isolated from all sense of risk. I have two main areas where I spend time, my bedroom for sleeping and my kitchen/living/dining room which was becoming gym, office, cinema and restaurant. I was, however missing the human contact, video calling is great, but it cannot replace seeing someone in the flesh, even just for small conversations. After 4 months of shielding I've spent a total of 30 minutes face to face time.

With our job role one of the key aspects is communication and interaction; to not have that is probably the hardest part. I'm now at 4 months and the other aspect that has been an issue is the motivation. As the project work slowed down, I was struggling to give myself focus. I would find myself sitting in front of a laptop trying to do work but being unproductive, which just discouraged and disheartened me. Feeling guilty for not working, knowing my team were doing so much. Having been in the same environment for so long the breaks of weekends and days off were not really feeling like breaks. I had a video meeting with my manager, and I discussed the issues I was having. He was sympathetic and supportive and reassured me that what I was doing had already been a huge contribution. This was such a different way of working… unprecedented times, and that mental health is as important to look after as physical health.

A recent work highlight was chairing sessions for the ERS virtual school, I had the pleasure of working with Professor John Gibson. Being able to watch the supporting presentations helped refresh my mind with the information I feel like I am losing. It was also very reassuring to have seen the positive comments come through and to have the interaction. I have been also working with European colleagues to write a lay summary of last years ERS congress, this was a challenge to find the simplest forms of language to use and explain our scientific practices.

Despite this difficult time, I am still a happy, healthy and positive person. There have been ups and downs throughout, but the ups far outweigh the downs. I am uncertain what is going to happen in the future. I hoped that as you are reading this, I would have been able to return to work, but the indications suggest that I will need to stay at home. I am just looking forward to when I can return, see my team and get back to a sense of normality, even if it is a new normal.

UKAS Accreditation and the IQIPS Scheme

UKAS is the United Kingdom's national Accreditation Body, responsible for determining in the public interest, the technical competence and integrity of organisations such as those offering testing, calibration and certification services.

Accreditation is the formal recognition that an organisation is competent to perform specific processes, activities, or tasks (which are detailed within the scope of accreditation) in a reliable, credible and accurate manner. The provision of accreditation must:

- **be undertaken impartially;**
- **be objective, transparent and effective;**
- **use highly professional, competent assessors and technical experts in all relevant fields;**
- **use assessors (and subcontractors) that are reliable, ethical and competent in both accreditation processes and the relevant technical fields.**

Accreditation delivers confidence in certificates and conformity statements. It underpins the quality of results by ensuring their traceability, comparability, validity and commutability.

The benefits of accreditation include being accepted nationally and potentially globally thus opening up opportunities for service expansion. Accreditation can highlight gaps in capability, thereby providing the opportunity for improved organisational efficiency and outputs. Accreditation provides independent assurance of your competence. It can set you apart from the competition and enable you to compete with larger organisations. Accreditation is specified by an increasing number of public and private sector organisations.

UKAS accreditation against the IQIPS Standard is fully endorsed by NHS England as it provides an essential framework for provider organisations that deliver those services to engage with NHS England Objectives. This endorsement is confirmed in the NHS England position statement published in October 2016:

"We fully support a commissioning system focus on the prioritisation of accredited diagnostic services. We are confident that with continued resolute focus, accreditation will become the baseline standard for diagnostic services across the NHS in England."

The independent Regulator of health and social care in England, the Care Quality Commission (CQC) recognises the potential value of clinical service accreditation and peer-review schemes as information sources to support its inspections. Such schemes have the potential to provide useful intelligence and independent assurance that accredited services meet defined standards. If you as a service have gained Accreditation for the IQIPS scheme, then the CQC are less likely to require a review of your service on assessment.

UKAS accreditation is a tool that can be used to support commissioning in the provision of healthcare services that are safe, effective and continually improve the experience for patients. As such, accreditation aligns closely to a key objective of both local clinical commissioning groups (CCGs) and national specialised commissioners in England; driving up the quality of care for patients, whilst

delivering enhanced efficiency and productivity.

The accredited provider organisation must demonstrate that it has systems in place (procedures, protocols, policies, equipment, facilities, resources and workforce which are routinely implemented and regularly audited) to provide competent, safe and effective services to all users whether at its static, mobile and or domiciliary (including residential or nursing homes) settings. Each part of the service provision is assessed by UKAS as a separate element, and each must conform to the requirements of the IQIPS standard.

The first version of the IQIPS Standard, the standard for improving quality in Physiological Sciences, was published in 2012. All standards require regular review at 4-5 year intervals and the Accreditation Clinical Advisory Group (ACAG) that owns the IQIPS Standard has now been working on a review of the IQIPS Standard since 2018. This has involved representation across all eight disciplines of the scheme (Audiology, Cardiac Physiology, Neurophysiology, GI Physiology, Vascular Science, Urodynamics, Respiratory & Sleep and Ophthalmic & Vision Science).

On revising the standard, the group were keen to ensure that it was mapped in line with ISO 15189 whilst retaining a similar format of the current IQIPS Standard, in order to ease the transition for customers. The group also needed to ensure that it is fit for purpose to be used for the Ophthalmic & Vision Science community, which is the only discipline yet to be involved in the accreditation scheme. The new revision of the IQIPS Standard aims to be fit for purpose for any healthcare discipline wishing to work toward UKAS accreditation and will readily enable any future harmonisation of accreditation standards.

The accredited provider organisation must demonstrate that it has systems in place (procedures, protocols, policies, equipment, facilities, resources and workforce which are routinely implemented and regularly audited) to provide competent, safe and effective services to all users whether at its static, mobile and or domiciliary (including residential or nursing homes) settings.

The revised standard has had external consultation from wider stakeholders in its development and has recently been out for its final external consultation. It is expected that IQIPS Standard V.2. will be published later this year.

There are currently only three organisations that are UKAS accredited for Respiratory & Sleep physiology. These are University Hospital Birmingham NHS FT, University Coventry & Warwickshire NHS Trust and Manchester University NHS FT.

To prepare for accreditation, UKAS runs a one-day Preparation for Accreditation Workshop. These workshops are aimed at management and personnel of non-accredited physiological diagnostic services/ providers who are considering applying for accreditation to the IQIPS standards. It includes practical exercises, covers a variety of topics and, most importantly, it provides a valuable opportunity for you to ask any questions. This workshop provides services/providers with an overview of the concept of

accreditation. It covers the key aspects associated with the accreditation process and provides service management and personnel preparing for accreditation and initial assessment with important information.

There is also a three-day Holistic Quality Management for the Healthcare Sector course. This course provides key elements of the Internal Audit course and effective Service Management subject matter in relation to healthcare standards. Participation in this course will develop skills and competence for various staff roles, including those responsible for quality management and coordination, technical leads or service management within an organisation. Learners will develop an understanding of how the organisational processes of a healthcare service provider can be combined effectively with the requirements of ISO 15189, IQIPS v2.0 and QSI 2019. They will appreciate how effective service management can be integrated with principles in key areas of compliance. This will include robust internal audit processes, competence development, non-conformance analysis, management review and their value to excellent service provision. The application of these tools will enhance the delivery of the service for its users, and in turn assist in the conformance with the requirements of Healthcare standards.

UKAS recognises that the process of accreditation for an organisation is never undertaken lightly, and that it involves input and investment of time from all areas of a business in order to provide a sufficiently robust and thorough assessment. As such, a considerable program of courses, workshops and free webinars have been developed by the UKAS Training Team, in order to smooth this process and aid participating organisations through accreditation.

These training options include on-site and virtual settings to provide as much flexibility (and safe social distancing in the time of the COVID-19 pandemic) for delegates and a comprehensive program of e-learning is also in development.

The feedback UKAS has received to these sessions has been overwhelmingly positive, with many organisations commenting on the helpfulness of the material as well as the opportunity to meet and question (if only virtually) the Assessment Managers that may conduct the accreditation process.

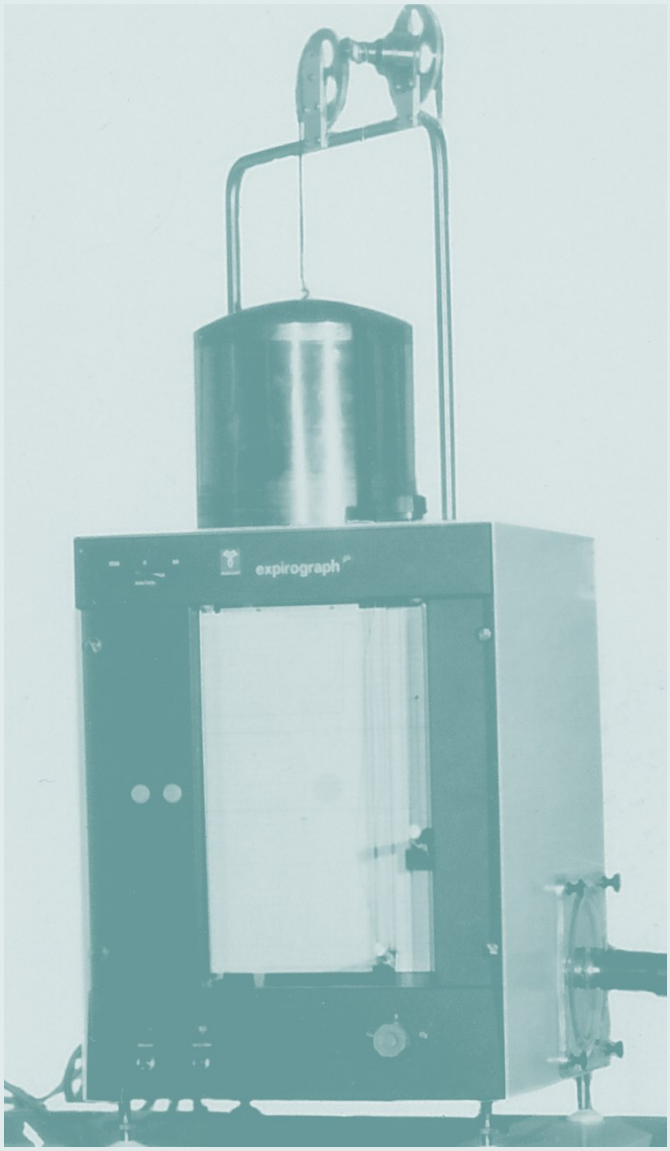
If you would like to discuss accreditation options with UKAS, please contact askiqips@ukas.com and full details of the training program can be found on the UKAS website. [https://www.ukas.com/services/accreditation-services/physiological-services-accreditation-iqips/apply-for-iqips-accreditation/].

Dr Laura Booth AuD MSc BSc CS
Senior Assessment Manager Healthcare

How it Works

Spirometers (History and Function)*

By Kevin Hogben



The original term 'Spirometer' was commonly a description for a Volume displacement device, these were used at the start of lung function measurements and took the form of a water-sealed fixed drum within a movable bell which had a breathing hose contained through the middle. The movement of the movable drum was, in its earliest form, a "hot" probe running against a Wax roller, this would scribe out the movement of the rise and fall of the bell, a ***Spirogram***.

The Dutch Firm *Godart* developed this commercially in Europe as a paper drum and pen with a two-speed motor providing better resolution on fast movements and a slower speed for longer studies. The pen to draw the trace was suspended over a pulley system with a counter balance weight; the fact that the bell rose when filled with expiration air, causing the pen to drop down the chart, is the origin of the presentation that EXPIRATION is drawn in the downwards position.

The Water bath Spirometer was considered to measure in the ATPS condition due to the water seal and so expired volumes were corrected to BTPS.

Water bath spirometers were messy, prone to growth of Algae if tap water was used, needed regular cleaning and often developed leaks.

* Note that this article is the author's personal view with emphasis on the UK market 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 industry needed "dry" transducers and the most common were the *McDermott* bellows spirometer (below, left) for inspiratory / expiratory measurements and the *Vitalograph* wedge Spirometer (right) for expiratory volume measurements, with a physical trace showing volume vs time directly in front of the subject, the first incentive Spirometer.

The dry spirometer now opened more possibility, they recorded in both directions and could accelerate without problem (water bath Spirometers when accelerated would often cause the bell to leave the water bath showering people around the device). The acceleration could be measured as the Differentiation of Volume over time, the product of which is Flow. Now we had a device that could measure both Flow and Volume characterising the shape to a fast responding X-Y plotter. One of the pioneers in this field was *Ohio Instruments* in the USA with the 840 10-litre rolling seal spirometer and the 842 version with a full analogue computer able to be switched on to a digital display to measure Peak Flow, the FEV_1 volume, the mid-flow parameters and the Forced Vital Capacity.

These products appeared at the end of the 1960's and early 1970's. *P.K.Morgan Limited* had been marketing the Cotes et al. Pulmonary Function device, the Resparameter, since its launch in 1965. However with the arrival of the advancing technologies the company decided to produce the Transfer Test series of instruments, which would exclusively use the rolling seal spirometer approach. Originally available in 8-litre capacity for adults and 4-litre capacity for Children, this continued until 1980, by which time Philip Morgan's son Patrick had established a business in the USA and found the American subject had larger lung capacity.. This led to the 12-litre version as the standard, which had a small advantage over the Ohio 10-litre capacity because with a centre point of 6-litres this accommodated most subjects to perform full inspiratory and expiratory from the centre point whereas with a 10-litre capacity the spirometer had to be offset to allow the inspiratory capacity and expiratory reserve volume to be measured without "bottoming" the spirometer travel.

The UK recorder company *Bryant Instruments*, recognising the need for fast accelerating plotters to capture the peak flow correctly, developed a range of X-Y plotters specific to Lung Function. The Bryant company eventually became part of *Gould*, the company that took over *Godart*, started to focus on medical technologies and eventually became *Sensormedics*.

The Ohio and Morgan Spirometers were mounted in the horizontal movement with an integral chart recorder for volume against time with a two speed Kymograph, whilst *Mijnhardt and Gould* 2450 systems used a vertically displaced rolling seal spirometer mimicking the water bath operation.

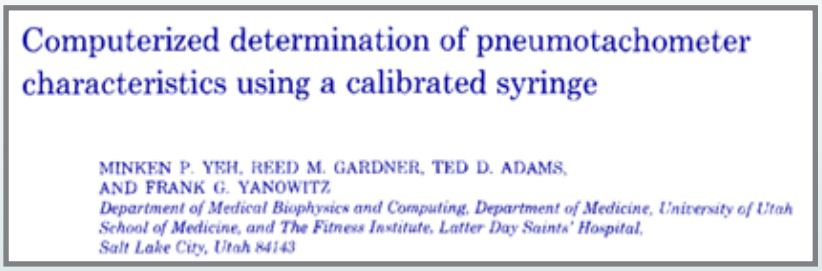
The spirometers used a central support bar to which a corded drive system could be mounted with a potentiometer that fed an amplifier able to provide the electrical output proportional to the volume displacement and this volume signal passed to a differentiator to supply the flow component. The construction was two stainless steel drums sealed with a silicone rubber membrane that rolled on itself, created from a cone on rubber, the stainless steel provided good thermal stability and with the silicone rubber seal offered a high resistance to microbes, both having tight molecular surfaces.

At one point the solution to using any X-Y plotter was the *DataDec*, this device had an early processor and was able to capture the flow-volume effort very quickly in high resolution then store this in memory before re-playing the data in analogue format to the X-Y Plotter.

Flow technologies existed also in the shape of pneumotachographs, these were primarily two designs, the *Fleisch* or the *Lilly*, each named after their inventor. The Fleisch used multiple pathways created by rolling a corrugated stainless steel sheet into a tube. The pathways produced laminar flow through the tube and on the outer circumference a block containing two pressure take-off points (one situated before and one after the block) was inserted in the middle and sampled by a differential pressure transducer, the corresponding pressure drop relative to the resistance of the flow pathway is the Flow passing through the transducer.

The Lilly design also worked on pressure drop across a resistance; this design had two cones with a central mesh barrier to create the resistance, the cones allowed the flow to dissipate across the total surface area of the mesh for laminar flow.

Pneumotachographs were inherently non-linear and had limited flow ranges; in the Fleisch range, the No. 2 and 3 models were for normal lung function and No.4 for Exercise type studies. Similarly the Lilly type had different models for different flow ranges.



Computerized determination of pneumotachometer characteristics using a calibrated syringe

MINKEN P. YEH, REED M. GARDNER, TED D. ADAMS, AND FRANK G. YANOWITZ

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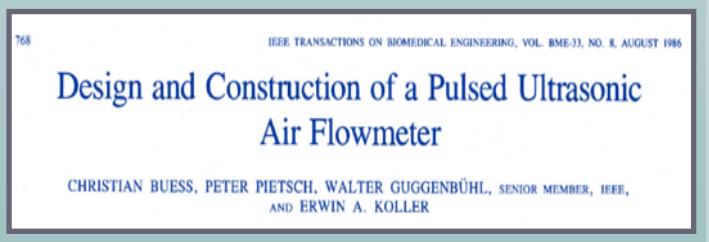
In 1982 a ground breaking paper appeared as a special communication from the American Physiological Society, demonstrating a method in which by using a known volume syringe it was possible to "map" all the flows by ensuring the flow integrates back to the original volume, thereby allowing a characteristic to be stored within a computer that allows the linearisation of the flow transducer over a full working range.

This was a dramatic step forward, the "Personal Computer" PC had only just started to surface in common use with the start-up company "Microsoft®" making it more accessible than other computer operating systems (CPM, Apple, BBC) and also linking it with Intel to develop processors that performed multiple tasks as opposed to other systems that used discrete pathways for specific tasks. Medical computing was leaping forward in offering "all in one solutions" to common tasks, collecting online data and presenting the data directly in a report format.



768 IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING, VOL. BME-33, NO. 8, AUGUST 1986

Design and Construction of a Pulsed Ultrasonic Air Flowmeter

CHRISTIAN BUESS, PETER PIETSCH, WALTER GUGGENBÜHL, SENIOR MEMBER, IEEE, AND ERWIN A. KOLLER

The addition of "processing power" started to open the way to use other forms of transducer to measure flow and volume characteristics. It was a long-held desire to measure flow with no resistance in the belief this would give the most accurate indications and with this in mind technologies such as Ultrasound appeared, this was first described in 1986.

In the UK the one of the first examples was the *Puritan-Bennett* spirometer, an ultrasonic beam passed across the breathing pathway would be modulated by the volume and flow passing the measuring point and therefore could be quantified. Other companies soon took on the modulation principle with laser beams projected across a normal breathing hose so this could be applied to any hose in ITU or other such places where a volume passing a point needed to be measured. This works in much the same way as the ultrasound method modulating the signal. This became known as the "time of flight" measurement. Ultrasonic flowmeters of this class are based on the principle that sound, travelling through a streaming medium, is sped up or slowed down by the movement of the medium, causing, for a fixed distance across the medium, a decrease in the downstream transit time and an increase in the upstream transit time. The changes in transit time can be related to the flow velocity. This form of measurement is still widely used by systems today.

Another method widely used in other industries and offering little or no resistance is the hot wire anemometer (mass flow sensor); this method commonly uses two probes directly in the path of the flow, one the hot probe, the other the cooler probe. As the mass passes down the tube the hot probe dissipates heat to the mass which then transfers the heat to the cooler probe and heats this probe. This is similar to the Wheatstone bridge used in the thermal conductivity principle for the measurement of Helium and other thermally conductive gases; the transit time between the two probes is directly proportional to the mass moving between the two points and so can be quantified by the swing in the bridge. This method, whilst offering little resistance to the passing volume/ flow, is unsuited for use in the presence of thermally conductive gases because it uses temperature movement and this is why it is not deployed in breathing circuits containing helium.

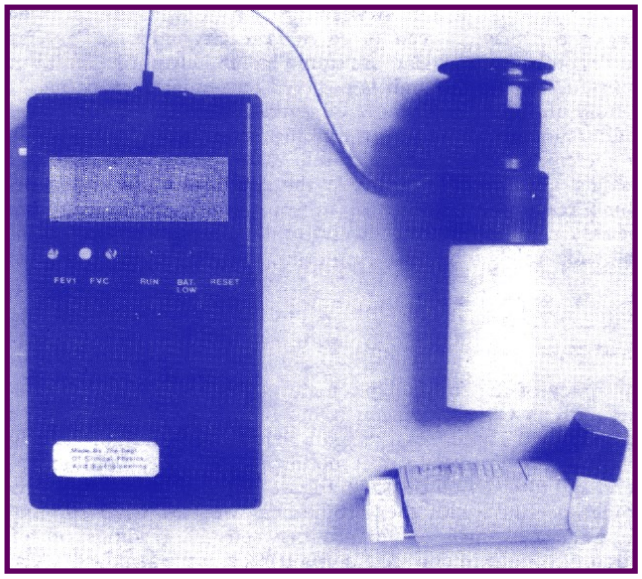
The last commonly used method in Respiratory measurement is the Turbine, this product is widely used in Ventilation equipment such as the Respirometer; this is a mechanical turbine used in the measurement of volume originally built by a small company, *Ferrari Medical*, based in the old fire station in Edmonton London, later purchased by Stainless Metalcraft, that we knew as Ferraris Medical before becoming *Nspire*.

The concept of the turbine led the medical and engineering departments of Guy's Hospital, London to consider an electronic digital version. They developed this principle as the "Pocket Spirometer", published in the British Medical Journal in 1982 and licenced to be built by *P.K.Morgan Limited*, Rainham Kent. The device used a swirl plate on one end of a tube to rotate a flat blade mounted on a spindle in the tube, the swirl plate caused the air to create eddies that rotated the vane. The rotations were counted by an infra red source and each time the beam was cut a rotation was logged as a pulse. For a linear unit, the volume of air passed through the turbine is proportional to the total number of pulses generated and the frequency of the pulse generation.

Pocket-sized device for measuring forced expiratory volume in one second and forced vital capacity

P J CHOWIENCZYK, C P LAWSON

Whilst the early version had a single emitter and collector, this was found to give false counts as a rotation may be missed or at the end of breath the vane would oscillate in the beam, so the Mk2 version had twin emitters and collectors and a valid count was achieved only when it had passed both points.



At the time this came to market, Phillip Morgan was sceptical it would catch on as a device and the then Sales Manager Mr Danny Quirke asked to take the product out of P.K.Morgan and formed *Micro Medical* to produce this and a range of complementary and popular instruments still on the market today. New work by the original inventors, has looked to build on the initial success of this principle in recent years,.

The last method found deployed in Lung Function is that of the Flexible orifice, which originally came to P.K.Morgan Limited in 1985-86 with Dr Colin Michael Lewis, who joined the company and brought a development he and his colleagues had worked on in South Africa, the ELF (Electronic Lung Function). Presented originally as illustrated (left), this used a differential pressure transducer and a resistance, which was not fixed, but like the petals of a flower that could distort in the airflow depending on the velocity. At low flow the petals were quite tight giving a high pressure drop; as the flow increased the petals would open in the airflow to provide less resistance to the effort. This method relied heavily on the computer to have a "lookup table" that reflected every flow under low and high conditions. In practice the device worked well and was later used as the central transducer for the ZAN range of instruments based around the Handy 100.

In summary, there has never been an "ideal" transducer and the choice of how to measure both Flow and Volume is very much determined by the situation, the gases that may be present and the measurement conditions. Volume is a function of partial pressure determined by the content of the gas volume being measured, temperature, pressure and humidity.

The common form to calibrate volume is to use an other known and calibrated volume source and to compare one volume with the other. This assumes the conditions of measurement are the same; the manufacturers of Calibration syringes actually state in the certificate of the syringe the conditions at the time it was calibrated. For this reason when using gases that do not resemble the gas used to calibrate with requires either additional corrections based on the content and viscosity of the gases (Martin Miller added an excellent appendix to the 1993 ERS Guidelines on this subject, pertaining to Pneumotachographs) or the measuring transducer is calibrated with the gas composition that it will be measured with.

Too often minor errors are attributed to: failing to ensure the conditions are correct, allowing an offset to flow when the calibration is performed, or failing to ensure the conditions entered for BTPS correction reflect correctly at the point of measurement.

In the days of Spirometers (water bath or dry), the measuring transducer was distal to the subject, often by a 1 metre tubing length; the assumption at the point of measurement is that the gas leaving the subject at 37°C in the lung has in one metre cooled back to the room temperature where it is measured. The water vapour content has always been a point of debate; with a water sealed system, it was assumed the total circuit is subject to humidity. With a dry circuit, in the absence of high speed humidity transducers it was assumed the volume was neither wet nor dry hence J.E. Cotes suggested a middle ground BTPS correction offset from the ATPS and NOT from ATPD conditions.

With modern close-coupled transducers at the mouth, inspired air is relative to the ambient room condition whilst the expired condition is assumed to be 28 – 32° at the lips still fully saturated, so different mathematical corrections are applied to inspired and expired quantities.

Within the UK we are fortunate that most sites are at or close to sea level so altitude correction is unnecessary and most sites sit within 50 miles of the coast so in general the humidity is 50%.

As volume is fundamental to ALL measurements we make there is no compromise for accuracy. Therefore regardless of the transducer, the need to perform a daily verification of the values obtained by the measuring transducer are essential to good working practice and laboratory management.

Aidan Laverty

A round-up of ARTP forum discussions since the April 2020 issue.

Top Forum

The best of the ARTP Forum

Obviously these are exceptional times and so there was one main topic dominating the forum during the period April to (early-) July 2020. The forum proved its worth during this time and was in such demand that the below text is grouped to provide a flavour of the themes at the time.

There was much praise for ARTP COVID-19 group and access to the forum for BTS and BSS members was approved to reflect this.

"An excellent piece of work, it's extremely helpful.", "Great work ARTP!", "really useful and timely"

Are lung function tests aerosol-generating procedures (AGP)?

The hot topic, with responses differing depending on the area of the country the hospital was based at. Is reversibility using a nebuliser an AGP?

Which (Body) temperature threshold would prompt a PFT appointment to be cancelled?

Alternative (non-AGP) tests were sought:

Can PEF be used in lieu of spirometry? How about impulse oscillometry? Other unforced manoeuvres? The suitability of performing walk tests on a treadmill?

Can Sit-to-stand testing be used in place of 6MWT? Wayne Donnelly, from Liverpool University Hospitals asked: *"Do many people have much experience with "1 min Sit-to-stand test (1STST)". Our hospital is looking for simple ways to test oxygen desaturation with a view to assessing patient faster and safer before discharge in the current circumstances".*

Alan Moore replied *"This test has been around for a while. The 1-MSTST involves using an armless chair and the performance of as many sit-to-stand procedures as possible in one minute without the patient using their upper limbs. This poses an interesting picture of something akin to a variation on Irish dancing. Reference values are available and I have attached the paper. As that paper points out, this test is largely a test of lower limb muscle strength and endurance. There is no measurement of SpO_2 involved. In those individuals with limited mobility for non-respiratory reasons, this may not be the ideal test in my view. As, presumably, the elderly may be a significant population to be looked it, I would suggest they are not an ideal set of patients for this. For example, as a mere non-sprightly 65 year old, performing anywhere near 30 of these manoeuvres in 1 minute would simply not be possible for me given a dodgy left knee. I seriously question the worth of this test in the context you are looking for. I would have thought that a straightforward 6 minute walk test would be better. If you can't spare 6 minutes, then perhaps shorten the duration or try 2 flights of stairs and measure SpO_2 - always a good test".*

Adrian Kendrick suggested *"One of the things you might wish to consider is whether or not a VA could be used in place of TLC in patients with a spirometry suggestive of restrictive defect. if you are going TLco measures, it reduces patient contact time and gives a good approximation of whether you have a reduced TLC anyway".*

A question was asked about the use of filters for CPET testing which prompted a detailed response from Kevin Hogben

Cleaning/Disinfection

Are the guidelines for decontamination of nebulisers similar to those for masks and for lung function equipment?

The use and the price of filters, the use of humidity exchange filters in place of Isoguard prompted detailed responses from the COVID group.

Are FeNO filters bacterial filters?

How long do we leave laboratories before being able to clean?

What are the required number of air changes per hour? Can we use a portable extractor fan to improve this?

Recycling/cleaning masks query. How could we adapt vented masks?

A much-responded to topic was entitled **"Make your own exhalation port. Almost"**. Replies involving the possible sharing of a template evolved to a request for a design for Venturi barrels. Another related post was Roy Dean in Kings Mill who found an open source template for creating face shields. Peter Moxon at Royal Wolverhampton followed up with 3D printer files for exhalation and oxygen ports.

Oximeters

A question about the provision of single use wrist straps for oximeters led to many responses: Francisco Piai from Western Sussex supplied photographs of some "he prepared earlier" using Velcro straps. Bev from Gloucestershire suggested disposable tourniquets. Glyn from Dudley uses Patient ID wrist straps. Emma from Macclesfield suggested cohesive bandage. It was also mentioned that alternative bona fide 'disposable plastic straps' are available from all good stockists!

The use of NIV and/or oxygen

The COVID group produced a handy table providing the estimated delivered FiO2 at differing levels of CPAP

The use of wall CPAP aka "High Flow CPAP"

The use of CPAP with type 1 respiratory failure

When can we resume CPAP trials? The answer at the time of posting (April 17th) was "not yet".

CPAP and "proning" the patients—? Effectiveness

Does a CPAP Machine Return/Amnesty Letter exist and would anyone like to share one?

FiO_2 Table (nationally of hospital oxygen supplies being put under strain)

Also the use of oxygen concentrators

New approaches to testing

Kim Wilkins, in Southend University Hospital enquired about Sleep diagnostics - said they were continuing with equipment drop-off plans, which was felt to be a good idea and several centres had already started this, generally by using postal oximetry, some by couriers. Louise Tobin, from Cardiology in Royal Surrey County Hospital noted they were providing 'drive thru' cardiac pacing clinics. This led others to investigate whether 'drive thru' spirometry was feasible. Measurement of height was felt to be a problem but ulnar length or arm span were considerations as replacements for this. Infection control was felt to be solvable. Testing in "the open air/gazebo" was also floated but it was mentioned that this may be impractical in a typical British summer [where] "the rain changes from horizontal to vertical, the temperature hits double figures more than twice a week and gales drop below 10mph".

Resumption of testing

Finally there were many emails around to the resumption of 'business as usual' for both sleep and lung function. Inevitably the question of when it was 'safe' to test lung function following a positive COVID-19 test arose.

Call to action

Dear ARTP membership,

I'm writing to inform you that we have launched an ARTP file resource.

Some of you have requested access to certain types of documentation and resources that we do not have available on our website, so we have created a Google Drive folder open to all our members.

The idea is that we can each contribute files and documentation to the drive so that other members may easily source information. At present, you will find a Covid19 support folder, which includes useful resources such as 3D print files and NIV Vented masks.

We are asking all of you to provide information you think might be useful for others, such as department SOPs and Business Cases, new ideas for innovative working practices, etc.

The Google Drive is Read Only, so while we can all access the information, nobody can edit or change the files you share.

If you would like to contribute to the Resource please send your files to the ARTP Admin admin@artp,org.uk. Please highlight your email with 'Membership Files'. The Google Drive requires that your files are named in a specific way: what the document is_version number_Name of trust e.g. SOP Hypoxic challenge tests_v2_Maidstone and Tunbridge Wells

To access the Google Drive go to: https://drive.google.com/open?id=1TAVqxUmq8ogAh236UgVKBv8H5UOg7AFD

Please read the terms of use, found in the Google drive folder carefully, these documents may not be endorsed by ARTP. For official guidelines from ARTP please see the ARTP COVID-19 page on the ARTP Website:

https://www.artp.org.uk/COVID19

We hope you will all contribute to this initiative. Together we will create something useful for all.

Kind Regards,
Emma Ince
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Principal Clinical Scientist – Respiratory
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