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ARTP | Association for Respiratory Technology & Physiology

Inspire

INSIDE THIS ISSUE:

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FIRST WORD

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Hello again and welcome to the ARTP 2019 post-conference issue of Inspire. Having edited Inspire (and written this column) for quite a few post-conference issues I can honestly say I am running out of superlatives to describe how well organised the conference was. As usual there were excellent speakers, posters and poster presentations reviewed in a supportive manner. Add in the fun of a city like Glasgow, stir in a wee dram and surprisingly good weather then you have the recipe for something special. You can view some images from the conference on page 58, read the abstracts from page 62 and see what the manufacturers were doing in the 'On the Blower' round-up from Matt. The minutes from the conference AGM are also in here (page 60). Talking of conference presentations, there was Matt O'Neill, Chair of Narcolepsy UK, explaining life with narcolepsy and how managed to cope once he was diagnosed in middle age while in a high-powered City job. See also the latest S-News for more about this. No one could fail to be moved by Dr. David Chinn's tribute to Prof. John Cotes. Dr. Gary Davies' revelations about air travel made me glad I took the train up.

This is a bumper issue. It contains some of the articles written by members in response to receiving a grant from ARTP to attend the Glasgow conference (pages 8, 52 & 54) and the 2018 European Respiratory Society (ERS) conference (pages 14 & 22). The latter articles are both sleep-related, which shows how many articles both Inspire and S-News are receiving lately—keep it up! There are several excellent articles in this group.

That leaves the regular features; On the Blower we have heard about, Harry has diligently compiled 'Top Forum' (page 56), hot topics from the ARTP forum and I can see already he will be busy with this for the next issue also! Dr. James Stockley, new Chair of ARTP Research Committee has stepped up to drive 'Fresh Air' (page 46) forward, initially with a timely review of SLP.

What else? Oh yes, ARTP has a new Chair, Julie Lloyd, who I am sure you will know. I am grateful to Julie for putting her 'Word from the Chair' together before jetting off to Kathmandu. I can almost hear the outgoing Chair, Dr Karl Sylvester, breathe a sigh of relief! I should also like to add my thanks to Karl, in support of what Julie has said in her article and also for his help with Inspire over my years as Editor.

This leaves another glorious image of respiratory technology from the past in 'From the Museum'.

Finally, the sad news that you may have heard on ARTP forum, of the passing of Dr Maureen Swanney, ex-president of ANZSRS. Professor Cooper has written a fitting obituary to Dr Swanney on page 6.

I hope you enjoy this issue, please keep the articles coming in and let me know if you have any ideas as to how Inspire can be improved. My thanks to all contributors and those who have helped me with this issue.

Aidan Laverty

A WORD FROM THE CHAIR

Julie Lloyd

Honorary ARTP Chair

Hello and welcome to this, our post Conference edition of Inspire and my first in the role as Chair. I would like to open this first message with my sincere thanks to Dr Karl Sylvester, our past Chair who has done an outstanding job in taking ARTP forward as an organisation. He has made the ARTP more inclusive and more responsive to the needs of the members whilst enhancing and furthering the influence of ARTP at a national level. It is not without some trepidation that I take on this role after Karl; they are big shoes to fill (at least a size 10!), but he will continue to offer his guidance and wisdom in his new role as ARTP Past Chair. Karl is not the only key member of ARTP that has stood down this year, with Joanna Shakespeare stepping down as Education Chair. Joanna has been hugely committed to education at all levels and her Chair role has been defined by innovative ideas, strategic thinking and, most valuable, her tireless efforts to raise the profile of education for all respiratory and sleep scientists. However, she has not managed to make her escape quite yet (despite her best efforts), as she has been elected as ARTP Vice—Chair and I look forward to working with over the upcoming months to take ARTP forwards during these changing times we find ourselves in. The Education Chair role has been filled by Dr. Vicky Moore and I can't think of a better person to continue the work that Joanna has stared. Vicky was formerly Chair of Spirometry and has been key in ensuring that the ARTP spirometry process is fit to meet the demands of the national registration program for all practitioners of spirometry. She will be ably supported by Edward Parkes, who has stepped down as Research Chair to take on the role Vice-Chair of Education; the vacancy as Research Chair will be taken up by Dr James Stockley who is a Research Clinical Scientist and well placed to take this group forwards. Last, but most definitely not least, ARTP Sleep has also had some changes at the top, with Dr Vicky Cooper stepping down as Chair and Sara Parsons now picking up from the excellent work that Vicky has done and continuing to take the sleep agenda forward.

Given that this is the post Conference edition, I thought it may be a good opportunity to reflect on what is our main event of the year. From the feedback we have received from the delegates, the ARTP Conference was a real success with some of the highest delegate numbers that we have seen for some time and the welcome was as warm as ever in Glasgow. Hopefully there was something on the program to interest everyone with sessions on rare diseases including an excellent session from Dr Alice Turner on alpha 1 anti-trypsin deficiency, the extreme physiological challenges of being a Royal Air Force Pilot presented by Dr Gary Davies, the life and times of Professor John Cotes fondly remembered by Dr David Chinn and the high quality research presented by you, our members. I would like to thank everyone who contributed to making this conference the high quality successful event we have come to expect from ARTP and I would like to extend particular thanks to our manufacturers whose continued support is vital to the ongoing success of these events.

We now begin the important planning of our next Conference in Birmingham in 2020 and the valuable feedback from Glasgow will help us shape the program for this event; there's still time to send your suggestions for Conference sessions for next year if you

feel that there is something that we have missed previously or something new that you feel we should present. The location of the conference will be somewhat of a homecoming event for me, having worked in and around Birmingham for my whole career as a healthcare scientist. Birmingham is a vibrant and exciting city that continues to develop at pace, particularly with the arrival of HS2 in to the city. Its central location means there are great transport links by road, air and rail, so getting to the Conference couldn't be easier and if you do have time to spare, Grand Central, just above New Street station is well worth a visit – just don't make the mistake of getting your Brummies' mixed up with your 'Yam Yams' and you'll be absolutely fine (try listening to the accents in 'Peaky Blinders' compared to 'Raised by Wolves' and it should all make sense!). Please keep an eye on social media for upcoming Conference announcements, particularly those of you planning to submit an abstract – successful submissions will be notified in plenty of time for the Early Bird deadline and Conference bursaries are available.

As I write this, I am busily packing for a trip to Nepal to deliver respiratory teaching and training to the staff who work in hospital in Kathmandu, the capital of Nepal and Ampipal, a small village in the Gorkha District

Spirometry training in a hospital in Kathmandu

There is a very high incidence of respiratory disease in Kathmandu due to the weak healthcare system, uncontrolled vehicle emissions, emissions from industries and smoke emitted from brick kilns. Sadly, it now has one of the highest levels of pollution in the world and this is impacting on respiratory health at all ages. Seeing the healthcare challenges facing Nepal first-hand really does bring home how vital the NHS is and what fantastic work we all do every day as healthcare professionals, despite the challenges we currently face such as workload, recruitment and funding.

I really hope you enjoy this edition of Inspire, and find it thought provoking and stimulating. I look forward to working with you all as your Chair and hearing your thoughts for the future directions of ARTP.

Obituary

Dr Maureen Swanney B.Sc., M.Sc., Ph.D.

1954-2019

Dr Maureen Swanney, Clinical Scientist and Scientific Director at Respiratory Physiology Lab, Christchurch Hospital, New Zealand passed away at home on 17th February 2019. She was diagnosed with an incurable cancer in autumn 2018 and didn't survive for very long despite the best care and support from clinicians, friends and family.

She worked in lung function in Christchurch from 1978 until last year (40 years) and was head of the lung function service from 1993 onwards (26 years). She met her late husband Dr Paul Egermayer at the Princess Margaret Hospital, Christchurch and married in 1996. She became President of the ANZSRS (1999 – 2001) where she was a driving force in developing the scope and accreditation of Lung Function services and was passionate about quality and standardisation of lung function services. She developed local primary care lung function services in Christchurch which still have an impact today.

She was a good person who has done so much to set standards and support our profession "down under" and worldwide. She was kind, generous, full of fun and passionate about our science and services. She was someone who has made a real difference and built strong friendships within our profession on a worldwide basis.

She was a remarkable female scientist who has pushed the boundaries of the profession for both women and scientists in what was a predominantly male and medical world when she started her career. She has been on many ATS/ERS Standards committees, was a current member of our GLI group and written some seminal papers on lung function over the years. Her research covered many important areas of lung function service;

- Spirometry Training Courses and community services
- Biological Controls
- GLI Reference equations and test interpretation

Most importantly was her PhD work on the validation of the FEV_6, which was all part of a theme of making lung function easier to deliver in primary care, but making sure quality and safety were maintained for patients at the same time.

She loved coming to the UK and spending time here whenever she was in Europe and attended ARTP conferences several times. She was awarded an ARTP Lifetime Achievement for her work. Towards the end of her illness she read the messages and prayers/wishes from ARTP colleagues that were sent, so I'm sure she knew the friendship and warmth we had for her at such a difficult time.

Indeed, Damian Muncaster who became Chair of ARTP, first met Maureen at our Glasgow conference. He remembered that she was charming and passionate about forging

links between the ANZRS and the ARTP. She was always responsive to all emails he sent her whether it was regarding sharing standards or even desperately begging for a job! She was great fun, and he dug out this email she sent to after the devastating Christchurch earth quakes.

The lab was not too bad. We had a large cylinder fall over but it did not explode! Several ceiling tiles down, computer screens and filing cabinets lay in funny places and angles. Plaster dust everywhere. But all the equipment is working just fine. We were testing people at 9 am Monday morning. I was amazed by the fact most people turned up for their appointments. There was no public transport and with the state of emergency I thought no one would come. Just shows how important blowing and panting is for some! The universities and all the schools are closed. It is all a bit weird.

We are on the fourth floor and I do not like the swaying with aftershocks. The other worry is that they think we may have another big one…… It is hard to describe the experience of the 7.1 'shake' early Saturday morning. It was terrifying, very noisy and pitch black. It lasted for about a minute which seemed like forever! I was hanging on to the bedroom doorframe which was moving and could hear lots of crashing.

Not even the earthquake stopped testing!! This was typical of her great leadership, resilience, practicality and strength of character.

Our own Dr Adrian Kendrick remembered the first time he met Maureen back in Perth, Western Australia many years ago, up to the last time he briefly caught up with her;

"*She was the most charming, knowledgeable and lovely person and our conversations were always interesting and fun. She had a great sense of humour! Maureen's contribution to our discipline has been immense and her passing, way too soon, is a sad and huge loss. RIP, Maureen*."

Also, Andy Robson remembered Maureen;

"*We have lost one of the giants of the discipline. Maureen was always willing to pass on her expertise to anybody who asked for her opinion. I remember having a rare old natter with her (and my wife) at the 2012 ERS in Vienna on the (decidedly non-physiological) topic of birdwatching. RIP Maureen, you have left us far too soon, and you will be missed."*

Maureen has been a powerhouse of clinical respiratory physiology over the years and she was on the current ATS/ ERS Spirometry Standards Group and was partaking in teleconferences only in November/December 2018. It was from this Taskforce that I was informed of her devastating illness by her friends and colleagues including Prof. Kim Prisk, Prof. Bruce Thompson and Prof. Graham Hall, all key members of the international respiratory physiology fraternity of which Maureen was central.

Her contribution to ERS conferences will be missed as she was always presenting some interesting new aspect of lung function service to Group 9.1 poster sessions; and she was due to speak this year as well!

Maureen Swanney was an ARTP Special Award winner which recognised her great work towards global respiratory physiology standards. She was made a Fellow of the Thoracic Society of Australia and New Zealand (one of only 3 non-medical practitioners to be given this award) last year.

She was a fine example of a how successful women in science can be an inspiration to all our respiratory physiologists and scientists. She is survived by her mother Patricia and her four siblings. We will all miss her, but bask in the glow of the great work she has done for our profession throughout the world. May she rest in peace.

Professor Brendan G Cooper,

March 2019.

ARTP 2019 CONFERENCE GRANT WINNER

Diagnosing Occupational Asthma: A Review of Techniques

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Introduction

Asthma is a respiratory condition associated with chronic inflammation and increased airway hyper responsiveness, typically presenting with variable airflow limitation[1,2]. Work-related asthma includes work exacerbated asthma (WEA) where a worsening of pre-existing symptoms follows an occupational exposure, and occupational asthma (OA) when symptoms are initiated as a result of the exposure[3,4]. Differentiating between WEA and OA is difficult[3,5], but is essential in terms of the implications and patient management[1,6].

Approximately 15-20% of adult cases of asthma are attributable to OA[5–9], and the incidence is increasing[5,6]. Early diagnosis is essential and current guidance aims to raise awareness, provide evidence-based recommendations, identify areas for further research, and improve the diagnosis and management of OA[1,7,10].

Diagnosis

Typically, OA symptoms improve away from the workplace and deteriorate either immediately or after a latent interval post exposure[2,5,8], and a positive answer to the recommended screening questions "*Are you better on days away from work? Are you better on holiday?*" should prompt further assessment[1,5,7,11]. Obtaining an occupational history is critical[11], however a recent audit found records were made in only 14% (55/396) of working-age asthma patients and 23% of high risk patients[12]. Despite the high sensitivity of a clinical history, false positives and low positive predictive values render it is most valuable for excluding OA diagnosis[7,8,11]. Symptoms have a low specificity due to their identical nature with non-OA and misrepresentation, influenced by confounding factors such as anxiety[1,5]. A recent study found a high prevalence of hypochondriasis in patients with suspected OA[4]. It is therefore recommended throughout the literature that objective tests should be used to support diagnosis[13].

Serial Peak Expiratory Flow Measurements

Serial peak expiratory flow (PEF) measurements are useful for confirming a workplace- symptom relationship[3,5,11]. The recommended minimum requirements for PEF records are PEF 4 times daily for a 2 week period away from work, followed by a 2 week period at work, but longer, more frequent records have a higher sensitivity and specificity[1,5,7,11,14]. Interpretation is based on differences in diurnal PEF variation or deterioration of mean PEF, at work compared to away. There are several methods of analysis including; visual, statistical, and computer-based analysis[15]. Although visual analysis by experts has higher sensitivity, recommended computer systems such as OSAYS-2 aim to reduce inter-operator variation[11,15].

Serial PEF measurements have many advantages; they are non-invasive, readily available, inexpensive, convenient, and portable[3,11,14]. The measurements are "feasible" with return rates of 78- 85%, and acceptable records in >60% patients[1,15]. Measurements have a high sensitivity (70-87%) and specificity (80-100%) for diagnosing OA dependent on the quality of the recordings1[3,6–8,11,15,16]. Despite its strengths, there are also limitations associated with serial PEF. It cannot

identify the specific cause of OA[15], or distinguish between OA and WEA[1,3,5]. Quality control issues include lack of compliance, suboptimal effort, poor patient technique, and fabrication of results[5,6,15,16]. Patients should be educated on technique, and reproducibility should be assessed by observing repeated manoeuvres[15]. In addition to patient error, there are quality control issues associated with PEF devices. Adeniyi *et al.* (2013) recorded serial PEF in expert staff using 4 different spirometers and concluded that differences in quality criteria accounted for significant result variability. Confounding factors include the use of asthma treatments, unrelated respiratory tract infections and exposure to irritants. Consequently, it is recommended that patients record events in an accompanying diary, and they are removed before analysis[6,11,14,15]. Furthermore, serial PEF is inappropriate for suspected severe reactions[15], and pre and post shift recordings when the response is delayed[1].

Specific Immunoglobulin E and Skin Prick tests

Recent reviews have produced pooled estimates of sensitivity and specificity for Skin Prick Tests (SPT) and Specific Immunoglobulin E (IgE):

Table 1. Adapted from (Lemière, 2013; Nicholson *et al*., 2010)

	Sensitivity (95% confidence interval)	Specificity (95% confidence interval)
SPT for LMW agents	52-73%	86%
SPT for HMW agents	81%	60%
Specific IgE for LMW agents	31-36%	89%
Specific IgE for HMW agents	74-82%	79%

*SPT= Skin Prick Test, LMW= Low Molecular Weight, HMW= High Molecular Weight, IgE = Immunoglobulin E

Both tests have demonstrated significant association with HMW agents[17]. Although one study found an association with LMW agents, only 45% of subjects had detectable IgE[18]. Neither test is specific for OA diagnosis[1,8,11], and positive results can be found in asymptomatic subjects[1,5–7,11]. Furthermore, there is a lack of available standardised allergens[7,8,11]. Despite these limitations, their high sensitivity and negative predictive value support their diagnostic value for exclusion of OA[6,11].

Specific Inhalation Challenge Test

Specific Inhalation Challenge (SIC) tests are often referred to as the "gold standard" for diagnosing OA[1,5–7,19], and it is therefore difficult to quantify their true sensitivity and specificity[20]. SICs must only be performed in specialist centres[7,20]. The procedure involves a control SIC prior to exposure, followed by a gradual increase in exposure of the suspected agent whilst repeated forced expiratory volume in 1 second (FEV_1) manoeuvres are performed, and finally an extended period of monitoring which aims to capture late asthmatic responses[5,7,11,20]. Exposure type is dependent on the nature of the occupational agent and workplace environment; soluble agents can be inhaled through a nebuliser, or within a sealed exposure chamber, whereas non-soluble agents require a specific challenge room. In certain cases, it may be necessary to perform a workplace SIC.

SIC interpretation can be complicated, and a single negative result cannot exclude OA[5,21]. There is debate regarding the positive threshold with OA guidelines recommending a reduction in FEV_1>15%[7] or 20%[6,11], whereas SIC guidelines argue this cut-off is "arbitrary" and subject variability should be considered[20].

SICs are not always required or readily available in non-specialist centres, and may only be indicated when the cause of OA remains unknown, as SICs are essential for determining a specific causal agent[1,5–7,20]. There are additional associated difficulties which contribute to their underuse; the test is time consuming[1,5,7], and mimicking the work environment can be difficult. Furthermore SICs are the most expensive diagnostic test for OA[20], and have

not yet been standardised for several known occupational agents[1]. False negatives can occur when the subject is challenged with the wrong substance type or concentration, in SICs following prolonged absences from work, and with use of asthma medications[6,11,15,20]. False positives can also occur as a result of non-specific bronchoconstriction to an irritant[6,20]. Although these false responses are acknowledged, little is known about their frequency[21]. The main factor limiting SIC availability is concern over severe adverse reactions[21], however these are rare (< 3% of positive SICs)[7,20], and closed-circuit laboratory systems help to reduce the risk[5,11,20]. Workplace SICs also reduce the risk of accidental overexposure, however they cannot be blinded, do not identify the causative agent, and there are no standardised methods[6,11].

Non-specific reactivity

Although a negative non-specific reactivity (NSR) result may aid exclusion of OA diagnosis[5,6], use of a single test for diagnosing OA is not advocated[1,7], and only a few limited studies have investigated serial and paired measurements[1,8]. There are a number of associated quality control issues including methodological disparities[7,20], positive threshold variation (15-20%), and varied time intervals between the exposure and test[7]. Patient-related factors include corticosteroid use and respiratory tract infections[11]. Although it has been suggested a positive post SIC NSR indicates a requirement for further SICs[6,20], one large retrospective study of 665 subjects found that more OA patients had normal baseline NSR results than non-OA patients (27% vs 8%)[17].

Induced Sputum and Exhaled Nitric Oxide

Activated inflammatory cells and mediators are thought to play a key role in OA, and inflammatory changes precede changes in lung function[5,6,17,20,22]. SICs induce eosinophilic inflammation in sensitized patients[22], and a recent study demonstrated a significant correlation between sputum eosinophilia >3% and increased decline in FEV_1 ($p= 0.042$)[23].

Induced sputum tests are non-invasive and serial measurements can be made over time[22]. However, obtaining sputum samples can be difficult and time consuming[5,22,23], and given its low sensitivity and specificity, guidelines recommend it should only be used to aid interpretation of ambiguous SIC results[1,7].

Elevated levels of exhaled nitric oxide levels (ENO) have also been suggested as a biomarker for OA associated airway inflammation[8,24]. ENO for assessing non-OA is already well established[1,24], and it is non-invasive, simpler, more accessible and less time consuming than obtaining sputum samples[5,8,20,22,24]. However, evidence for its use in OA is inconsistent[5,11,20,24]; a recent study found no significant difference in ENO levels between subjects with a positive SIC versus negative SIC ($P>0.05$)[25], whereas another retrospective study determined a high sensitivity (70-80%) and specificity (79- 80%) for diagnosing OA[26].

A more recent development to aid OA diagnosis is the non-invasive measurement of exhaled breath condensate pH (EBC-pH). One study demonstrated a reduction in EBC pH> 0.4 during a 2 week period of exposure compared to baseline measurements was highly specific for OA diagnosis[27]. However, there are limited studies and further research is required before these tests can be validated for OA.

Management

It is well established that the level and length of continued exposure determines OA patient prognosis, and therefore early diagnosis and immediate exposure removal is crucial[1,5,7,11,28]. Although one study found exposure avoidance did not significantly affect patient prognosis, the sample size was small and biased towards severe asthma[24]. Further recommendations include using respiratory protective equipment although it does not prevent OA[1,5,11], and ,at a minimum, annual workplace health surveillance measurements[1].

Conclusion

Diagnosing OA may involve multiple rounds of extensive tests, and associated costs are 10 times higher than non-OA[29]. However, rapid and accurate diagnosis is essential due to the prognostic, social and financial impacts of the disease and continued exposure.

Despite a limited number of randomised controlled trials, a large number of relevant study designs, and high-quality reviews have demonstrated the strengths and limitations of the diagnostic techniques discussed in this case study. The knowledge gained from this evidence should be used with careful judgement of each individual circumstance, when selecting the diagnostic tool, and interpreting results. The diagnostic value of each method is increased when used in conjunction with other tests and alongside a clinical and occupational history; therefore it is possible to avoid delays in diagnosis even when access to SIC tests is limited.

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Assessing an auto set trial period for obstructive sleep apnoea patients

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Introduction

Obstructive sleep apnoea (OSA) is a form of sleep disordered breathing (SDB) where the muscles surrounding the pharyngeal walls relax during sleep and the throat becomes occluded preventing airflow for 10 or more seconds resulting in hypoxemia during sleep[1]. This can be seen in Figure 1, where the tongue and soft palate are occluding the airway.

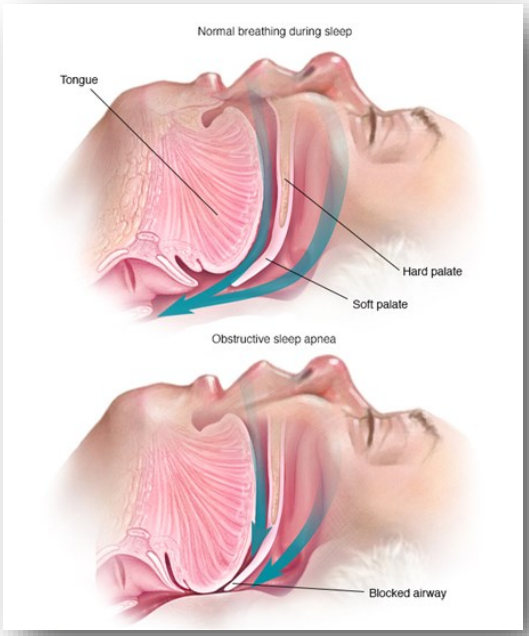

Figure 1: A graphical representation of a normal airway and airway occluded by both the tongue and soft palate[2].

The prevalence of OSA is estimated to be 5% in adults according to various studies[3]. The individual is typically left feeling fatigued and sleepy, which has a physical and psychological impact on day-to-day activities. In most cases it can easily be treated via continuous positive airway pressure (CPAP), however other options are available for individuals who cannot tolerate this therapy. CPAP is described as a means of reducing upper airway resistance, improving CO_2 excretion[4]. CPAP is a small electronic device that acts as an air compressor. A hose attaches to the device along with a mask, (these can be full face or nasal fitting to secure to the patient). Through this, room air is blown through at a set pressure. This acts as a pneumatic splint to stent the airways open when the correct pressure is achieved. The lack of sleep and sleep quality can cause other health problems in the long term. Individuals with OSA are suffering from poor quality sleep each night and failing to fully rest, as such they are at higher risk of cardiac disease, stroke and metabolic diseases such as diabetes, along with other preventable diseases.

There are currently no guidelines for health professionals when initiating a patient on AutoSet CPAP. Therefore, this study aims to address the lack of guidance on how to initiate AutoSet CPAP and provide a starting point on which future research can be built.

Aims and objectives

The department in which the audit was carried out previously loaned AutoSet devices for a 14-night period. The objective was to determine if the same parameters could be accurately established from a shorter trial period, specifically a one-night trial, to determine optimum patient treatment for OSA.

The specific parameters that the study aimed to compare were:

- 90% pressure – This is the pressure at which the device is at 90% of the maximum pressure that is required when maintaining the patient's airways and preventing an apnoea
- Compliance – This is the duration (hours) that the device is delivering pressurised air to the patient to maintain their airway.
- AHI – This is an index measurement, counting the number of times a patient's airways occlude or have a ≥30% decrease in flow for more than 10 seconds.

There are wider implications to the National Health Service (NHS) and the wider economy as the cost of treating other diseases and conditions related to OSA (surgical or pharmacological) are far higher than the cost of the equipment used to initially treat OSA. This study can provide the basis for further research in the creation of guidelines for initiating AutoSet CPAP therapy. Consequently, a shorter trial period has the potential to reduce waiting times for CPAP treatment, allowing a larger number of patients to be initiated on treatment quicker. This has the potential to improve patient outcomes in a number of ways; through improved quality of life from improved sleep duration and quality to risk reduction of diseases associated with OSA.

Methods

This study used AutoSet CPAP devices; these are specialised devices that adjust the delivered pressure depending on the status of the patient's airway. The devices record the amount of time the patient has used the device (compliance), as well as their AHI and the 90% pressure required to maintain their airway. During the patients' initial 14-night trial, their device is accessible via modem, uploading their data directly to an online server where it is accessible by physiologists within the department; this allows an insight in to how the patient is adjusting to therapy. The data was collected from the online server once the patient had completed their trial and attended their next appointment for a fixed pressure device.

The demographic data that was included was gender and BMI and have been specifically chosen as these are the risk factors for sleep apnoea. The exclusion process is displayed in Figure 2, where 25 newly diagnosed patients (who never received OSA treatment prior) were set up on AutoSet CPAP on a 14-night trial; however the final sample was 13 patients. The first stage of the process excluded those who had no data for the first night of the study as these were vital for comparison and therefore no further data from the patient could be used even if they achieved 100% compliance. Also excluded were patients with less than 7 days (50%) usage; the rationale for this was based on the study by Chandrashekariah, Shaman and Auckley, (2008)[5] where they stated that a patient with less than 4hrs compliance is considered poor compliance. Therefore, patients not meeting these criteria were removed. The final exclusion criteria were if any demographic data was unobtainable (not disclosed) from patient notes. The process for inclusion and exclusions is described in Figure 2 below.

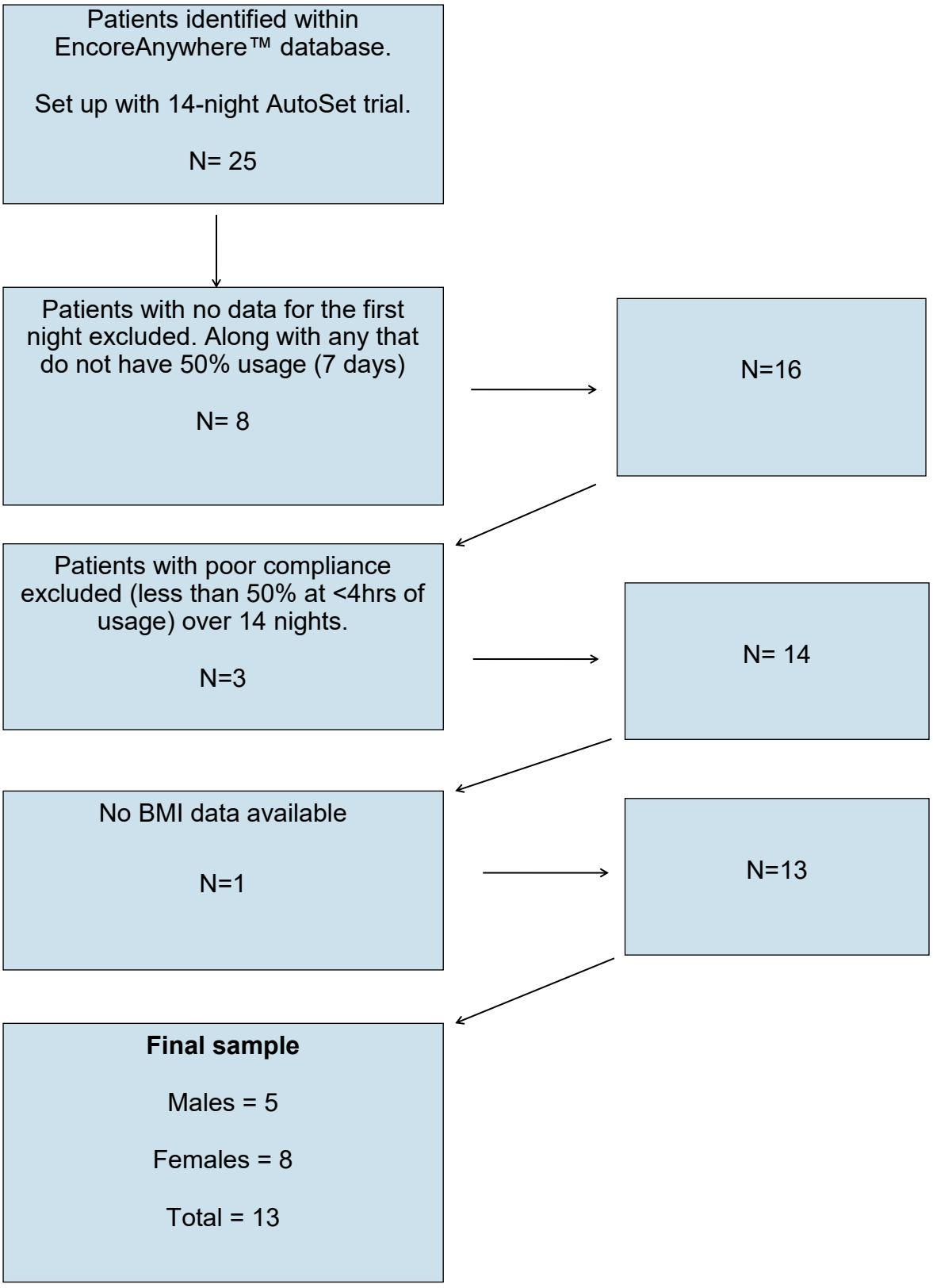

Figure 2: Flow chart showing the exclusion process

Results

There were 8 females and 5 males included in the study population. The mean BMI was 38.8kg/m^2. The standard deviation of 11.8 demonstrates the variation in BMI within the sample size and indicates the data points for the BMI of patients are more widely spread in relation to the mean; the mean and standard deviation are above a healthy BMI (this will be expanded on in the discussion and evidenced in Table 1).

Male	5
Female	8
BMI (kg/m^2)	38.8 ± 11.8

Table 1: Summary of patient demographics

Table 2 shows that AHI, compliance and 90% pressure had a decrease in deviation however, from analysing the data there was found to be no statistically significant difference between a one night and 14 nights AutoSet trial across all parameters .

	Mean ± SD	
	Night One	Mean of 14 nights data
AHI	5.6±4.4	5.4±3.5
90% pressure (cmH_2O) one night	10.9±2.9	11.1±1.6
Compliance (hrs) one night	7.9±2.4	6.8±1.3

Table 2: Summary of patient results

Figures 3-5 show all sets of data have similar lower limits, lower quartiles and medians, however average fourteen nights has a larger upper quartile, and this leads to a higher average over fourteen nights having a more spread inter-quartile range.

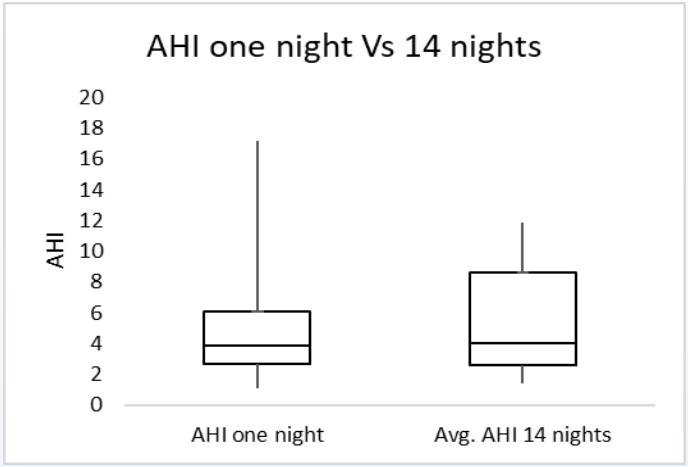

Figure 3: Box plots showing AHI from one night and 14 nights

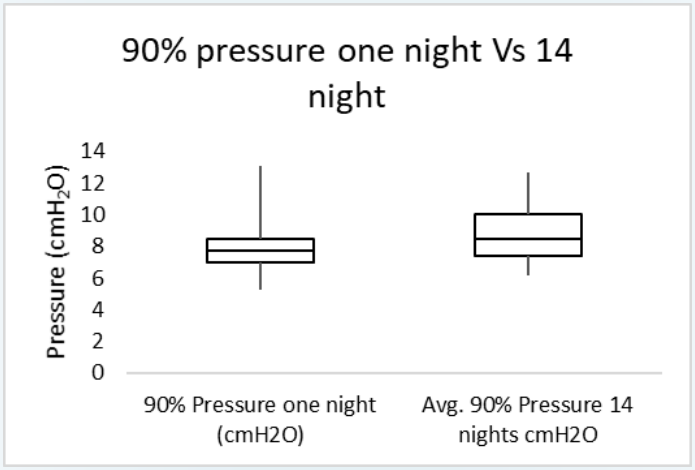

Figure 4: Box plots showing 90% pressure from one night and 14 nights

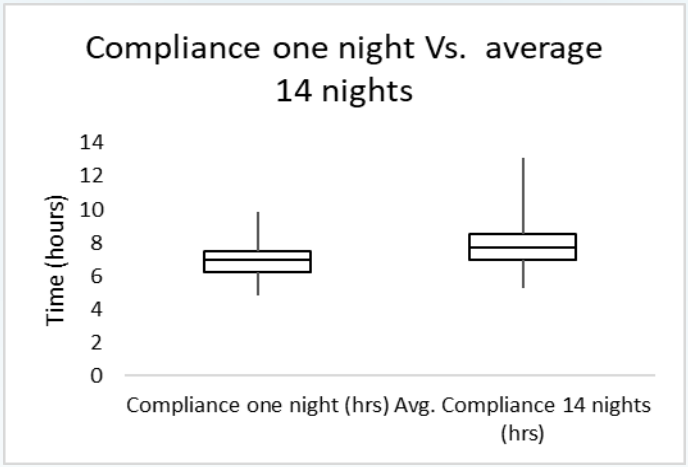

Figure 5: Box plots showing compliance from one night and 14 nights

Discussion

This research provides some generalisability as the selected cohort relates to the general population as a major risk factor and leading cause of OSA is being obese or overweight. The sample used in this study has a mean BMI of 38.8 ± 11.8 kg/m^2. However there are also anatomical risk factors. Within the study there were more females than males, contrary to evidence that OSA is more commonly diagnosed in men, however, this study did have a small overall sample size and there other reasons relating to health-care seeking behaviour in males that could be potential explanations, for example that males may be more likely to struggle to comply with treatment or are more resistant to seeking treatment[6]

As there are no clinical guidelines as to how a CPAP AutoSet trial period should be carried out these results can provide a foundation from which further research can be initiated. This study had thorough methods to achieve the intended outcome, utilising specific parameters that would determine the accuracy of a one-night AutoSet study rather than a 14-night study. This study did not take into consideration any existing co-morbidities, medications or other parameters that may affect a trial period such as mask. Similarly, categorising CPAP referral pathways, as either pre-operative, via the STOP BANG pathway or via their general practitioner (GP) from self-reported excessive daytime somnolence would be useful.

There were difficulties collecting demographical data, such as BMI, from patient notes as these data are not required to be recorded in patient's online notes unless they are under the age of 16. Typically it was documented patients are recorded as "overweight" or "obese", if the study had utilised a prospective methodology then this would have been avoided as all relevant data would have been obtained from the patient. Age is an indicator for OSA with it being more common in the over 50's, hence its inclusion on the STOP BANG questionnaire, hence this would have been a useful parameter to include to observe how applicable the study is to the wider population[7].

Determining whether CPAP parameters can be accurately determined in a one-night trial compared to fourteen nights was successfully achieved as there was no statistical significance in any of the parameters. A significant difference with this study compared to previous studies using AutoSet CPAP devices is the use of a new generation of CPAP machines that can monitor patients AHI without the use of PG study. The margin of error reduced in AHI and 90% pressure however there was an increase in compliance over the 14-night trial, this can be attributed to differences in patients becoming adapted to CPAP therapy; this can cause more hours of sleep due to less disturbance or fewer hours of usage due to better sleep quality.

The average AHI on the first night and average across the 14 nights was above what would be considered normal (<5). A low percentage mask fit would lead to higher pressures due to air escaping therefore reducing the effectiveness of treatment.

90% pressure and compliance were both analysed using a parametric test, specifically a paired T-test as the data for both were normally distributed. Figure 5, displaying compliance, shows that patients became more compliant after 14 nights and a reason for this may be that as patients become settled on treatment, their quality of sleep improves in addition to their becoming more accustomed to wearing the mask at night.

Pressure difference and mean have little variability as the factors that influence airway collapse such BMI, opioid medication, a reduction in weight specifically around the neck, and changes in medication may cause long term changes which would not be seen over the short-term period of this study.

Conclusion

The results show that there is no significant difference between any of the parameters collected during a one-night study and a fourteen-night study. Therefore, the use of a one-night study could potentially increase the number of patients treated on CPAP. CPAP therapy can prevent other long term conditions such as cardiovascular disease and diabetes[8,9].

In the first night there is high compliance as usage is inconsistent over the 14-night period. This can increase the number of patients being established on CPAP therapy. Further research in this area, and development of the methodology described in this study and an expanded sample size over a longer period could lead to clinical guidance on the time frame over which patients should be trialled on.

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A case of narcolepsy in a patient with mild OSA

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Introduction

Patient:

The patient is a 47 year old female Sales Assistant that complained of snoring and excessive daytime sleepiness (EDS). She reports that her husband has observed apnoeic episodes and occasionally she experiences choking sensations that arouse her from sleep. She suffers with type II diabetes mellitus and depression. Her BMI was 29.1 and Epworth Sleepiness Score (ESS) was 16/24 at first assessment.

Her sleepiness has been a long-standing issue and she has trouble staying awake in the daytime. She has often found herself sleeping in situations such as meetings, sitting on a bus and even whilst on the telephone, and often does not recall sleep onset. She gave a history of some occasional sleep paralysis, but there is no history of cataplexy or hypnagogic hallucinations.

Following this history, investigations were aimed at a diagnosis of obstructive sleep apnoea (OSA) initially. However, the long history of EDS and sleep paralysis lead to a clinical suspicion of narcolepsy.

Narcolepsy:

Narcolepsy is a disabling sleep disorder of the central nervous system with no known cure[1]. It is characterised by EDS, cataplexy, sleep paralysis, hallucinations when entering sleep (hypnagogic) or waking from it (hypnopompic), and a host of other additional features such as automatic behaviours and fragmented sleep[2]. In Europe, the prevalence of narcolepsy with cataplexy is estimated to be 30-50 per 100,000[3,4] and an additional 36% without symptoms of cataplexy[4]. Incidence is highest in the second decade, with a higher rate of incidence in men than women[4].

Cataplexy and sleep paralysis are pathological, dissociated manifestations of the generalized muscle atonia characteristic of REM sleep[5]. Cataplexy is described as 'the partial or generalised, almost invariably bilateral, loss of skeletal muscle tone and power in response to emotion, especially amusement, anger and elation'[6]. The duration of these attacks can vary, potentially occurring for several hours. Reflexes in deep tendons are absent during these attacks, and EMG findings from muscle electrical stimulation reflects those that occur during rapid eye-movement (REM) sleep[7,8].

Sleep paralysis is caused by the marked dissociation between level of alertness and muscle atonia that often occurs in sleep-onset REM (SOREM) episodes[8]. SOREM periods are a common feature of narcolepsy that is not characteristic of normal sleep architecture.

A history of sleepiness, cataplexy and sleep paralysis can lead to a strong suspicion of narcolepsy. Narcolepsy without cataplexy requires a history of sleep paralysis, hypnagogic hallucinations, and supportive evidence in the form of a positive multiple sleep latency test (MSLT) with a mean sleep latency of ≤8 minutes and 2 or more sleep-onset REM periods[1]. The MSLT involves a series of 15 minute naps with 2 hours of wakefulness between. The presence of REM in these naps is

abnormal and can indicate the presences of sleep deprivation or narcolepsy.

Case history:

INITIAL INVESTIGATION:

Multi-channel limited sleep study:

The patient gave a convincing history of OSA and therefore underwent a multi-channel limited sleep study. The data from the study is shown in Table 1 and Figure 1. There was evidence of mild OSA with an apnoea-hypopnoea index (AHI) of 10.2. She spent most of the night in the supine position and there was very loud snoring throughout.

Table 1: Results from multi-channel limited sleep study with patient information.

Age (years)	27
Gender	Female
BMI (kg/m^2)	20.6
Apnoea-Hypopnoea Index (AHI)	10.2
Oxygen Desaturation Index > 3% (ODI)	11.0
Mean SpO2	94.1%
Mean pulse rate (bpm)	85

Multiple Sleep Latency Test (MSLT):

The limited channel sleep study showed evidence of sleep disordered breathing that could be causing EDS. However, the history included episodes of sleep paralysis, and her sleepiness is seemingly disproportional to severity of OSA. Therefore an MSLT was performed to investigate narcolepsy (Table 2). The test showed an abnormal mean sleep latency time (<8 minutes) and one nap had suspected REM sleep. Sleep-onset REM (SOREM) occurs in cases of narcolepsy, but also in cases of sleep deprivation and therefore OSA. Two naps with SOREM are required for a diagnosis of narcolepsy, but there was a suspicion that the patient was taking an anti-depressant - a selective serotonin-reuptake inhibitor (SSRI). SSRIs are known to cause REM sleep restriction.

Table 2: Results from multiple sleep latency test (MSLT) showing minutes taken to reach each sleep stage in each 15 minute nap.

	Time to sleep onset (mins)	REM (Y/N)
Sleep 1	4.5	N
Sleep 2	2.0	N
Sleep 3	2.0	N
Sleep 4	3.0	Y
Sleep 5	3.5	N
Mean	3.0	

Outcome of initial investigation:

The decision was made to trial CPAP therapy whilst continuing investigations aim at identifying narcolepsy. CPAP therapy was tolerated well in the first month of treatment, but showed no improvement in EDS and her ESS remained high (15/24). She still continued to fall asleep on the bus and was at risk of losing her job due to several episodes of hypersomnolence at work.

FURTHER INVESTIGATION:

Actigraphy:

Sleep restriction needs to be ruled out as a cause of SOREM periods during an MSLT. Therefore, measurement of sleep periods was performed over a period of two weeks using an actigraph watch. Figure 2 shows the data for 5 days which was representative of the complete measurement. Her typical bedtime is midnight. On average she sleeps 7 hours a day, but this sleep is not evenly distributed throughout the days; she sleeps much less at night during the weekends and sleeps through the day – this is a common feature of a Friday/Saturday night on the town, but the patient denied such an occurrence. There are some infrequent naps, which is not necessarily an abnormal finding. However, some occur in the middle of periods of very high activity which is suspicious.

Polysomnography:

The patient underwent a full polysomnography (PSG) study whilst using her CPAP therapy. The hypnogram is shown in Figure 3. Despite sleep onset being < 5 minutes, the study was generally unremarkable; the first REM period is not pathologically swift and sleep architecture is normal. There are some arousals to wake from stage 3 sleep which can be associated with parasomnias such as confusion arousals. Sleep efficiency was 94%, there was a normal frequency of arousals throughout the night, and there were no periodic limb movements, respiratory disturbances or nocturnal awakenings.

MSLT:

The second MSLT provided convincing evidence of narcolepsy (Table 3). Mean sleep latency was 2.8 minutes and there was unequivocal REM sleep in 3 naps, possible REM in 1 and the fifth nap was not performed due to the presence of REM in 3 previous naps. There was no suggestion of sleep deprivation as the previous PSG showed an efficient night of sleep with >6 hours of sleep. Sleep deprivation shows a pattern of initially rapid sleep onset, with sleep latency increasing throughout the day. If REM is present as a result of sleep deprivation, it usually occurs in the early naps, but not the later naps. The presence of REM in ≥2 naps and mean sleep latency <8 minutes support a diagnosis of narcolepsy.

Table 3: Results from multiple sleep latency test (MSLT) showing minutes taken to reach each sleep stage in each 15 minute nap.

	Time to sleep onset (mins)	REM (Y/N)
Sleep 1	4.5	Possible
Sleep 2	2.0	Y
Sleep 3	2.5	Y
Sleep 4	2.0	Y
Mean	2.8	

Current Medication:

The patient is prescribed Sertraline (100 mg/day) and mefenamic acid (a NSAID for menstrual pain). Her type II diabetes is currently controlled by diet.

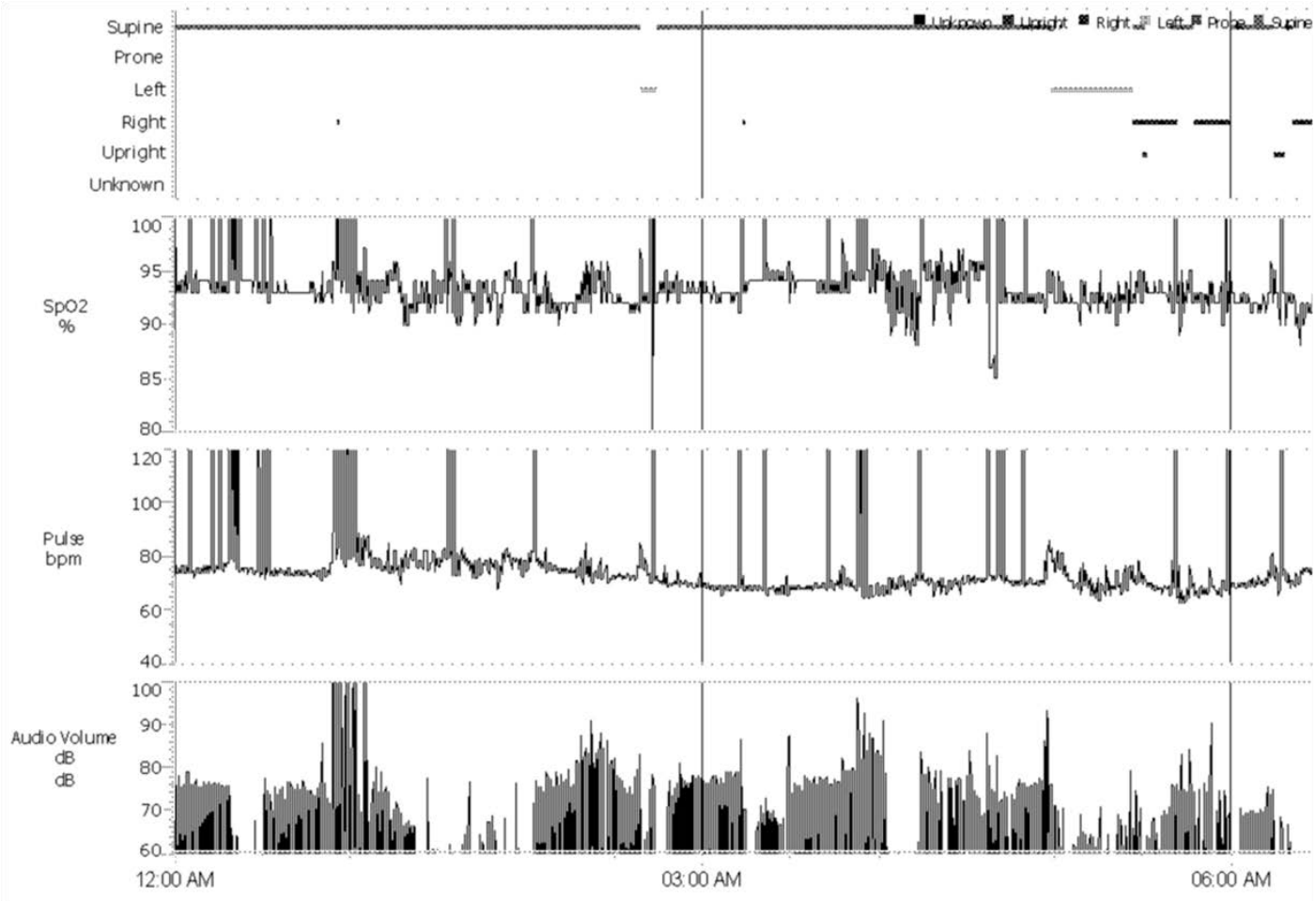

Figure 1. Multi-channel limited sleep study showing position of patient, pulse oximetry (SpO_2), pulse rate, and audio volume

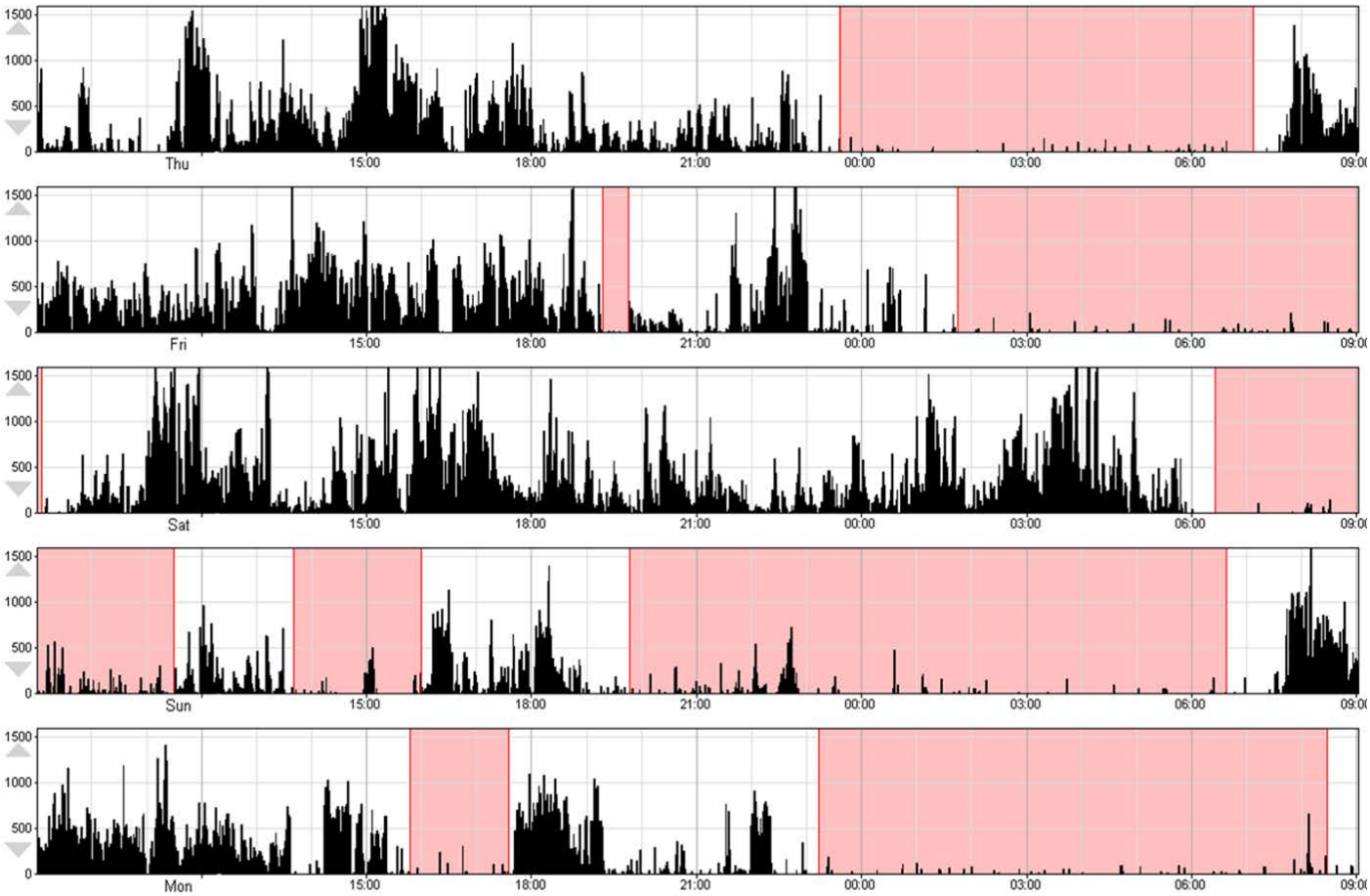

Figure 2. Activity measured using actigraph. Red sections indicate periods of sleep.

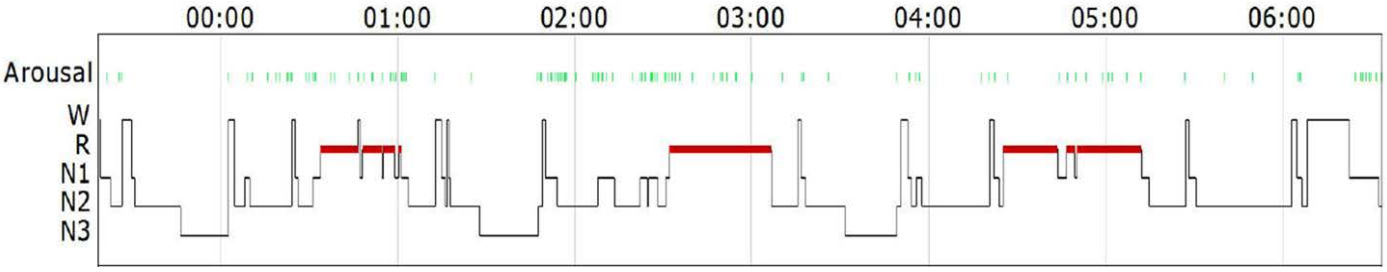

Figure 3. Hypnogram detailing sleep stage throughout overnight polysomnography. W: wake; R: Rapid Eye Movement; N1, N2, N3: stage 1, 2, 3 sleep.

Discussion:

Diagnostics:

Diagnosis of narcolepsy without cataplexy can be a difficult task; there are currently no highly sensitive and specific biomarkers for its presence and diagnosis may be dependent on both a convincing history and a positive sleep study. The time between first symptoms and diagnosis has improved over time. Median (IQR) time to diagnosis from 1980 to 2000 was 3.5 (1.5 - 7.25) years for all forms of narcolepsy, whereas in the previous two decades this was 14.5 (7.25 - 21.75) years[9]. The delay to diagnosis is significantly higher in patients without a history of cataplexy[9].

MSLT: The presence of two or more SOREM periods was found to have a sensitivity 0.78 and specificity of 0.93 for narcolepsy[10]. SOREM can occur in other pathologies including sleep deprivation and OSA. Approximately 4.7% of OSA patients may display 2 SOREM periods on an MSLT and independent predictors of this occurrence were male gender and severity of nocturnal desaturation[11].

Biomarkers: The presence of human leukocyte antigen (HLA) DQB10602 or HLA-DR2 haplotypes have been previously used to support of a diagnosis of narcolepsy[12]. This is because the interactions of these genes influence genetic predisposition to human narcolepsy[13]. These genes are found in 85% of patients with narcolepsy with cataplexy, but only in 50% of patients without cataplexy[14]. However, these genes occur in the population in a relatively high incidence and therefore are thought to increase the risk of developing narcolepsy, but not necessarily cause the development of the disorder[15]. This high prevalence in the general population lead to HLA-DQB1 and HLA-DR2 typing to be removed from guidance and superseded by hypocretin in the cerebrospinal fluid (CSF; [16]). Low hypocretin levels (less than one third of control values) in the CSF are important to a diagnosis of narcolepsy with cataplexy[17]. However, CSF hypocretin levels remain intact in patients with narcolepsy without cataplexy[18]. The summary is that there are no biomarkers that are effective at diagnosing narcolepsy without cataplexy.

Treatment:

There is no cure for narcolepsy. The treatments are focused on symptoms and general life management (i.e. education of the patient and family, sleep hygiene, etc.). Medical treatment of narcolepsy involves treating EDS and treating cataplexy or other REM sleep associated symptoms. Treatments are currently aimed at treating hypersomnia (e.g. stimulants, scheduled naps), cataplexy (sodium oxybate, antidepressants) and disturbed nocturnal sleep (e.g. hypnotics). This patient does not exhibit symptoms of cataplexy and therefore treatment for this will not be reviewed.

Treatment of EDS: Stimulants such as amphetamines, methylphenidate and modafinil are the main tools used by clinicians to treat the sleepiness associated with narcolepsy[2, 6, 19]. There is a wealth of evidence that suggests that

these drugs or a combination of them are effective in improving symptoms of daytime sleepiness and amount of unplanned sleep in patients with narcolepsy[20-22].

Sodium oxybate is a sedative/hypnotic medication which has shown to be a useful tool in the treatment of all the symptoms of narcolepsy. Objective sleepiness (measured with a maintenance of wakefulness test; MWT) and subjective sleepiness (via ESS) were improved vs placebo in narcoleptic patients treated with sodium oxybate[23].

Scheduled naps have been found to improve EDS, but are not as effective as stimulant therapies alone[20]. Scheduled sleep periods only seem to benefit those patients that remain profoundly sleep despite stimulant therapy[24].

Disturbed nocturnal sleep: There is evidence that Sodium oxybate improved sleep architecture in patients with narcolepsy and reduced nocturnal awakenings[25,26]. A systematic review for the American Academy of Sleep Medicine (AASM) found no evidence that traditional hypnotic medications improved sleep architecture in narcolepsy patients with or without cataplexy[21].

Antidepressants: There is a clinical consensus that antidepressants (tricyclics and SSRIs) improve symptoms of cataplexy and quality of life[2,6]. However, a Cochrane review of the use in antidepressants in narcolepsy found there was scarce evidence of antidepressants having a positive effect on quality of life or cataplexy[27].

Treatment of this patient: The patient experiences substantial difficulty due to EDS. Her sleep architecture during a PSG was not abnormal, and she does not suffer with cataplexy. Treatments should therefore be aimed at improving EDS. Initially she should trial a stimulant such as modafinil and her symptoms should be monitored.

Conclusion:

In conclusion, this patient demonstrated sleepiness that persisted despite treatment of her mild OSA. The description of sleep paralysis events whilst taking a full sleep history lead to a suspicion of narcolepsy. Narcolepsy without cataplexy is a difficult condition to diagnose and treat. It is a lifelong condition that has no cure, but treatment can be effective in improving symptoms. It is a case of trialling treatments and finding which is effective in the individual.

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FROM THE MUSEUM

Image by Dr. David Chinn

Critical Orifice Helium Analyser

This device consists of a tube 1 mm in diameter through which air is drawn by a pump (yellow connector, bottom) to create a vacuum of less than 0.58 atm. An aluminium plate with a hole 0.25mm is fitted over a luer fitting (top) plugged into the tube. This luer fitting constitutes the 'critical orifice'. Hypodermic needles 10 cm apart are fitted into the 1 mm tube to monitor differential pressure. The arrangement is surrounded by a brass tube through which hot water is circulated to prevent condensation from expired air. Helium is 36% less dense than air so when 100% helium is flowing through the tube the flow rate increases by a factor of about 3 and the differential pressure triples compared with that of air. The response time to a change in helium concentration is less than 100 ms. Though the analyser is non-linear it is the *relative* change in pressure rather than the absolute pressure that is important in monitoring the presence of helium in the expired air. Hence, it allows rapid monitoring of a change in expired helium concentration as occurs during the measurement of closing volume (phase IV). However, the system cannot be used to measure the slope of phase III.

Further details of the technique are available in Green M, Travis DM, Mead J. A simple measurement of phase IV ("closing volume") using a critical orifice helium analyser. JAP 33: 827-830, Dec 1, 1972.

Matt Rutter

Alan Moore

Prof. Brendan Cooper

ON THE BLOWER

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

Manufacturers Survey

Thank you to all those who responded to the survey, your feedback is always appreciated. Unfortunately not all the manufacturers were available to receive their awards on the night, but were still all very well deserved.

The award winners were:

Small diagnostics — Circassia

Lung function — Medical graphics

Sleep Diagnostics — S Med

Sleep Therapy — Fisher and Paykel

Manufacturers special mentions —

Andrew Allen

Andrew Welch

Dave England

Jim Horne

Kenny Simpson

Marc McDonnell

Patrick Jamieson

Travers Barr

Best conference stand — Vitalograph

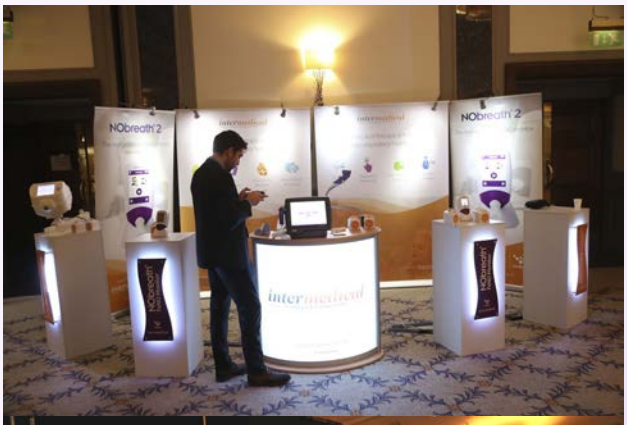
Grant winner — Trish Matharu

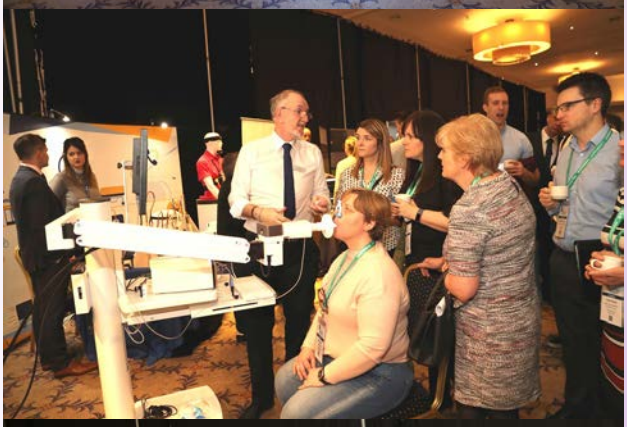
Well done to all the manufacturers

MR

FROM AROUND THE CONFERENCE

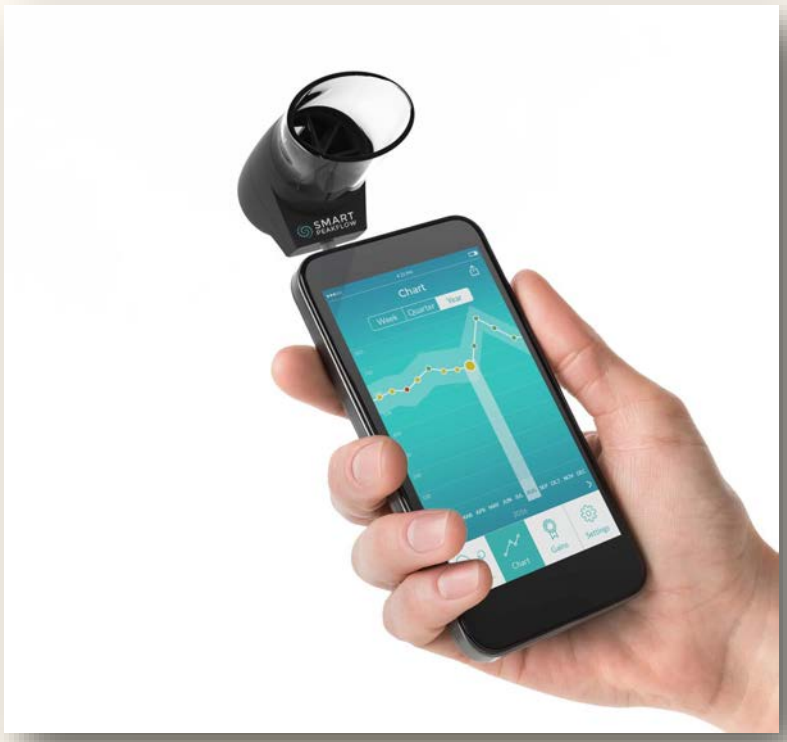
FROM AROUND THE CONFERENCE

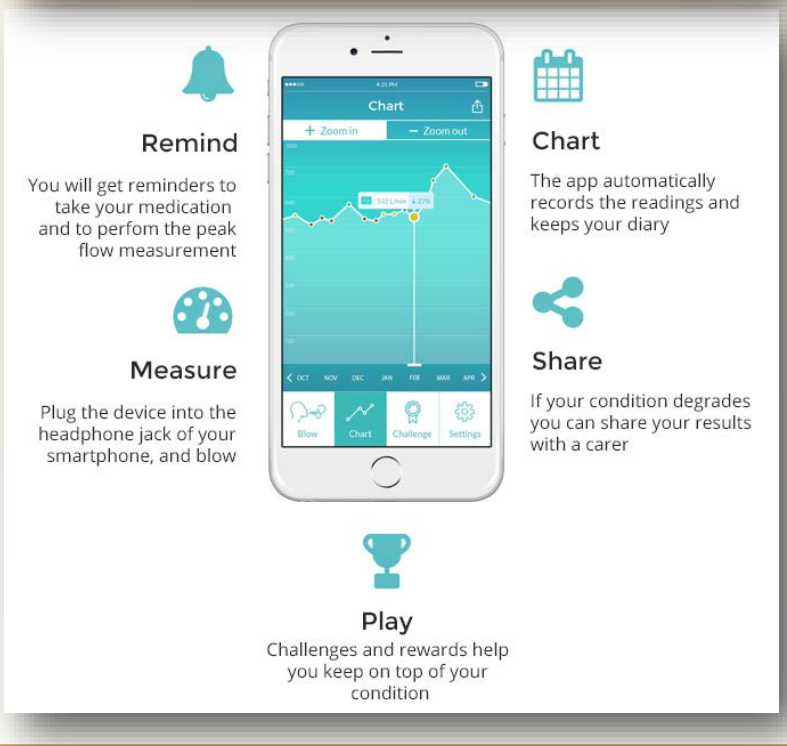




Captium

We were very happy to attend the ARTP conference for the first time to present our new smart peak flow meter. The device connects to a smart phone and using our app, can track peak flow measurements. These can then be sent to your healthcare professional. There has recently been an article about our Smart Peak Flow in iNews





Fisher & Paykel Healthcare

The ARTP Conference in Glasgow - what a great way to start 2019!

The team at Fisher and Paykel Healthcare would like to thank everyone who came along to see us at our stand at this year's event. We hope you enjoyed the conference as much as we did!

Conversations with many of this year's delegates are still highlighting that the mask matters most. Choosing the right mask is key to successful CPAP therapy and our Simplus, Eson 2 and Brevida masks have been designed specifically with comfort, seal and ease of use in mind.

In addition to discovering our award-winning OSA masks, many of you came to our stand to give Humidified High Flow (HHF) therapy a try. Some were happy to go with the flow, chatting to us over a cup of tea with 60L/min being delivered into their airways! We were also delighted to see so many of you attend our workshop looking at the use of HHF from hospital to home. This is a very exciting new area for us at F & P and we look forward to seeing the use of this therapy expand as clinical research in the UK moves forward.

Ending the conference by winning the ARTP Sleep Therapy Manufacturer of the Year Award truly was the icing on the cake. Thank you so much to all who voted - we can't tell you how much this means to us all.

Supporting educational events and the ARTP conference in particular is very important to us at F & P. We're already looking forward to the next meeting in 2020 and we hope to see you there!

Web: https://www.fphcare.com Twitter: @fphcare

Intermedical

Intermedical (UK) Ltd enjoyed a very successful ARTP Conference in Glasgow. Showcasing our range of Respiratory and Sleep Diagnostic equipment, feedback from the members was very positive.

Our Ndd range was well received as always with lots of interest in the EasyOne ProLab and EasyOne Air in particular. Members were impressed with the portability of both and with the Prolab being used more and more in the community setting, there were lots of exciting discussions had. The updated EasyOne Connect software allows seamless communication between all Ndd devices and of particular interest was the option to trend FeNO on the same report as Spirometry, D_LCO and lung volumes. As always, Ndd software is free of charge and can be downloaded on to as many PCs as required with no expensive user licences. Updates are also free of charge for life.

We also showcased the new Bedfont NoBreath FeNO monitor. A big improvement on the previous version, the NoBreath now has built in incentives to ensure correct exhalation speed, automatically eliminates poor quality tests and contains memory to enter patient details, store results and trend data. With extremely low running costs, the NoBreath certainly created a stir. You can find out how much you can save by clicking here: http://www.nobreath.co.uk/nobreathv2/secondarycare/#calculator

The Resmon Pro FOT/oscillometry device was recently used at the annual meeting of British Pigeon fanciers to help identify obstruction in this group of patients. We were able to detect early onset of peripheral obstruction in subjects who had normal spirometry. This could prove to be a key early indicator of this disease which has a very similar early pathology to idiopathic pulmonary fibrosis.

Our MIR range of spirometers also attracted interest, particularly the Spirolab with its large touch screen display and intuitive user interface and we also introduced a new overnight sleep system from Compumedics. Available later this year more details on this will follow…..

And finally we had lots of fabulous feedback for our promotion video. Whilst our hero came across more like Jonny English than Daniel Craig, we thoroughly enjoyed putting it together!!

And the chocolate truffle gift boxes also went down well too!!

nSpire

NSPIRE HEALTH

Many thanks again for visiting us at the conference it was great to catch up with so many of you and to meet some new faces.

It's no secret that Pulmonary Function Testing is underutilised and device variability is a problem. Left unchecked, this can lead to diagnostic errors that have a substantial economic and human impact on the NHS.

Due to this we had a lot of interest in our latest innovation Iris IQ™ from those of you who want to address this within their labs.

Until now, the tools available have not helped solve the problem because they cost too much and take too long to use. With Iris IQ™ the industry's first comprehensive, trust wide quality and pulmonary department management solution, you can improve quality significantly, in less time and while lowering the cost of care.

Click this link to watch a video and see how you can transform your department utilising nSpire Health's years of experience and latest technology (if you have trouble clicking the link, copy and paste this URL into your browser http://www.nspirehealth.com/transformvideo/).

Please don't hesitate to contact us if you have any questions.

Numed Healthcare

New Vertical Turbine Spirometer with Improved Low-Flow Sensitivity

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

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

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

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

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

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

PARI Medical Ltd

SPIROSENSE® IS AN INNOVATIVE SPIROMETRY SYSTEM, CONSISTING OF A PROFESSIONAL PC SPIROMETER (SPIROSENSE*PRO*) FOR USE BY HEALTHCARE PROFESSIONALS, WITH THE OPTION OF ADDING A MOBILE SPIROMETER (*MY*SPIROSENSE)

As a mobile unit, *my*SpiroSense is ideally suited for Disease Monitoring for progressive or difficult to manage respiratory diseases. For example in

- Difficult Asthma
- ILD
- NIV weaning
- Occupational Respiratory Patient Monitoring
- Neuro-Muscular Disease

It can be used by the patient at home and data simply downloaded to the healthcare professional. *my*SpiroSense can also help in supporting management decisions where quantitative data is required.

If you are involved in training your research colleagues on how to perform spirometer tests, why not consider *my*SpiroSense for Clinical Trials?

For further information email cilla.clayton@pari.com

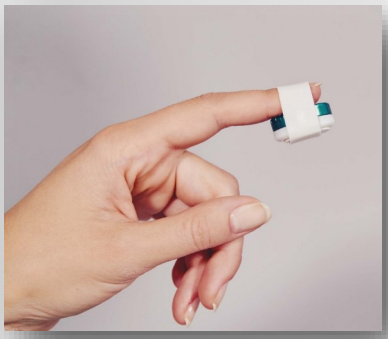
www.pari.com/spirometry

Stowood

We showed the new Viatom Checkme O2 overnight wrist pulse oximeter. This is compatible with Visi-Download, so you can analyse and create reports just as you always did with the Konica Minolta Pulsox-300i.

We showed the newest Embla PSG systems, the Embla SDx and Embla NDx. These are lightweight wired in-hospital AASM and Remlogic compliant sleep systems, to avoid any problems with wireless connection or battery problems. The devices have up to 92 channels and use the same consumables as the Embletta MPR PG wireless PSG system.

We showed the Ectosense Nightowl. This is a overnight sleep monitor, which is the newest device on the market to use Peripheral Arterial Tone (PAT). This gives ODI (Oxygen Desaturation Index, and AHI, all from one simple reusable sensor. The sensor is wireless, with wireless charging, and the smallest sleep screener we've ever seen. Stowood are planning to make this compatible with Visi-Download in the near future. We hope to offer as a capital item or pay-per-use.



We showed the Medlab CAP10, a capnograph with sidestream technology . The sample rate is adjustable between 60 and 150 ml/min, to allow usage on adults as well as on neonates. The CO_2 values are shown in mmHg, %Vol or kPa. By using the built-in, rechargeable battery it is possible to work up to five hours without mains connection. It has 100 h of trend memory for up to 10 patients, and an optional analog output of etCO_2, respiration, capnogram for connection to PSG systems. We hope to make this compatible with Visi-Download in the future.

We showed the Stowood Black series including Black Shadow, the only UK designed and manufactured overnight cardiorespiratoy/ sleep screener. Compatible with Visi-Download, now with a price drop for significant savings.

Vitalograph®
Your cardio-respiratory partner

Data you can rely on.
People you can trust.

VITALOGRAPH'S new portable lung function test devices were among the stars of the show at this year's ARTP Conference

The Compact DLCO and Compact PFT devices, developed using Morgan Scientific's ComPAS2 software, received a great deal of attention when they were unveiled at the two-day event in Glasgow. This is the first time that the market leading ComPAS2 software has been seen in the UK.

Vitalograph's new CompactPFT device with Morgan Scientific's ComPAS2 software.

We would like to thank everyone who came to the stand and who attended our workshops at this year's ARTP conference held at the Hilton Doubletree in Glasgow. Our early-bird workshop presenting the Compact PFT was fully booked, and it was standing room only at our second workshop discussing recent changes to DLCO guidelines.

Adrian Fineberg, Vice President of UK Sales and Service said there had been some fantastic feedback from delegates, adding: **"2019 is going to be a busy and exciting time at Vitalograph as we introduce new products, a new look and focus for our customers."**

The new compact devices offer all the standard tests required by a pulmonary function department and can be mounted on a desktop or trolley. A wheeled bag is also available for transporting devices between sites.

Vitalograph's stand, which featured interactive demonstrations of the PFT equipment and software, was voted best at the event by delegates. The ARTP conference is one we look forward to each year and we appreciate the recognition of the effort we put into the ARTP conference.

Vitalograph team at ARTP (L to R): Jennifer Colbourne Business Development Manager; Adrian Fineberg Vice President UK Sales & Service; Adrian Joyce Mechanical Engineer R&D; Michelle Gallagher Marketing Manager; Jimmy Strang Territory Manager; Andy Roebuck - Application Specialist, Vitalograph.

Adrian Fineberg Vice President UK Sales & Service Vitalograph presenting the iPad to competition winner Natasha Blakely, of Norfolk and Norwich University Hospitals NHS Foundation Trust.

The following companies were also present at the conference. For more information on their products, follow the hyperlink to their websites.

Baywater Health Care

BOC Healthcare

Circassia

Dolby Vivisol

Drive Devilbiss Healthcare

GVS Filter Technology

Intus Medical

Intersurgical

Itamar

Löwenstein

Medevolve

ON THE BLOWER

The following companies were also present at the conference. For more information on their products, follow the hyperlink to their websites.

Medical Graphics and Medisoft

Philips Respironics

Radiometer

RemServe

ResMed

S-Med

Schiller

SomnoMed

Vyaire

Dr. James Stockley

Fresh air

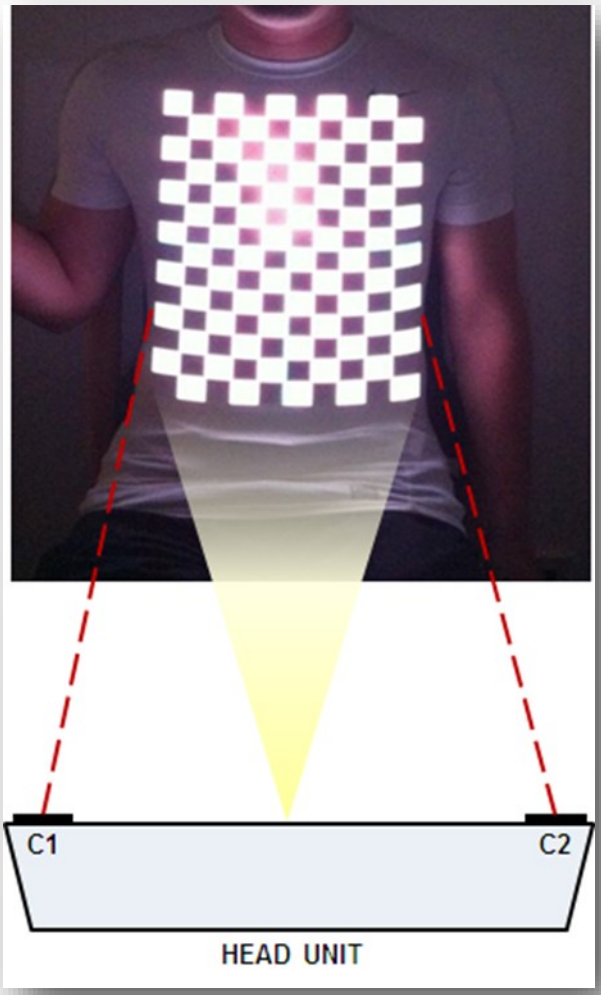
Structured Light Plethysmography – A Short Review.

Introduction

Traditional lung function tests such as spirometry require the use of a mouthpiece and nose-clips and, usually, for the patient to perform complex (often maximal) inspiratory and expiratory manoeuvres. While these tests provide valuable information about the functional status of the lungs, they can be difficult for some patients to perform and do not provide information about ventilatory mechanics during relaxed, tidal breathing. Therefore, tidal breathing measurements can be both a useful adjunct to routine tests but also a substitute for patients (particularly infants) that cannot obtain traditional lung function.

The concept of analysing thoracoabdominal movements has existed for over 30 years. A pioneering study by Peacock and colleagues[1] used a fixed, striped pattern of light to map the size and shape of the thoracoabdominal wall and its change in shape during breathing. Since then, a number of other non-invasive techniques have been developed, which include respiratory inductive plethysmography[2], optoelectronic plethysmography[3] and impedance pneumonography[4]. Inductive plethysmography requires the placement of thoracic and abdominal transducer bands and is most commonly utilised during overnight polygraphy/polysomnography. In a similar manner, impedance pneumonography measures the change in impedance of electrical current between electrodes placed on the thoracoabdominal wall. For optoelectronic plethysmography, the pre-test procedures are more complex and time-consuming, requiring the careful placement of numerous reflective markers around the trunk before their motion can be captured by multiple cameras.

Structured light plethysmography (SLP) is the latest technique for assessing tidal breathing mechanics. It has the advantage of a very simple and quick “non-touch” pre-test set-up (the fitting of a plain, white t-shirt) and is easy to perform in patients of all ages (even as young as two years old) in both a seated and supine position.



Principles of Operation

SLP uses normal light that is projected onto the patient's torso as a "chessboard-like" grid (Figure 1). There are over 200 intersection points between the black and white squares, which are tracked with 2 cameras at 30 frames per second. These data are used to construct a 3D image of thoracoabdominal wall movement. A more detailed explanation of the mathematical principles is provided by de Boer and colleagues in their original paper[5].

Figure 1: A graphical representation of the "chessboard" light grid projected from the SLP head unit onto the patient's torso. The movement of the intersections are tracked with two cameras (C1 & C2). SLP can be performed on bare skin but, for routine clinical practice, it is more appropriate to use a skin-tight white t-shirt (e.g. a sports compression top).

The SLP generates both a traditional volume-time and a flow-volume trace. However, volume and flow are not measured directly and equate to the degree and rate of thoracoabdominal displacement, respectively. Despite this, Motamedi-Fakhr and colleagues demonstrated that the majority of SLP "flow" measurements compared well to simultaneous flow measurements from a pneumotachograph[6]. In addition to this full body analysis, the thoracoabdominal grid can be analysed by compartment; most commonly thorax versus abdomen (Figure 2), although it can also be separated into left versus right, quadrants, or any other custom analysis.

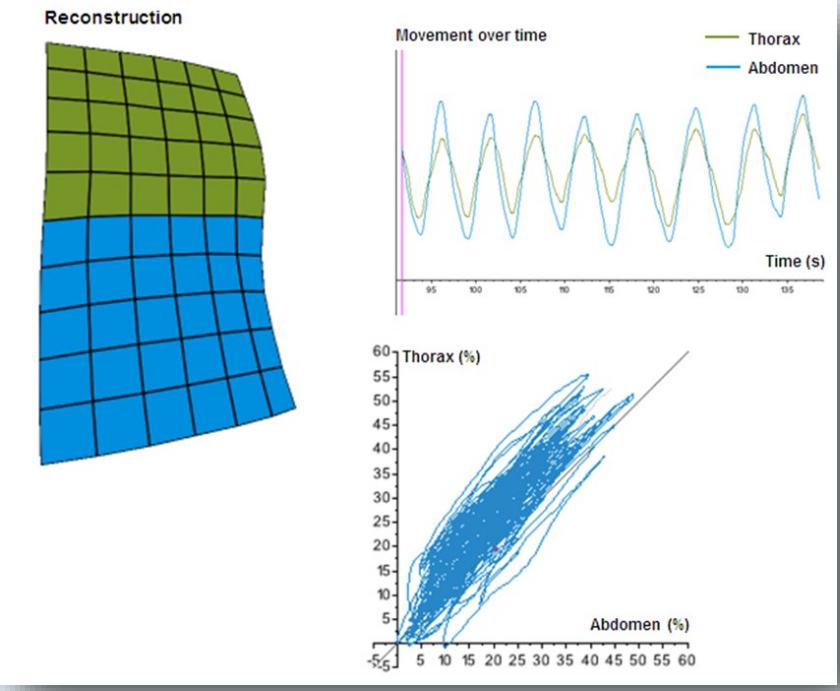


Figure 2: 3D reconstruction of the thoracoabdominal wall, which is separated into thoracic (green) and abdominal (blue) regions. The top graph is a volume-time trace and the bottom graph is a Konno-Mead plot[7] of thoracic versus abdominal movement.

Outputs are averaged over all breaths within the 3 – 5 minute testing period. Full body parameters include breathing rate, inspiratory time (T_I), expiratory time (T_E), total breath time (T_{TOT}) and their respective ratios. Of these, T_I:T_{TOT} may be the most useful clinically as evidence suggests it relates to the work of breathing[8]. The ratio of inspiratory to expiratory flow at 50% tidal volume (IE_{50}) is calculated from the tidal flow-volume loop. Previous studies have shown that IE_{50} relates to airflow obstruction in COPD[9] and can be used to demonstrate a bronchodilator response in children with asthma[10].

Once the SLP grid is separated into regions, further outputs can be generated, namely regional contribution (expressed as % total displacement) and synchrony. There may be instances when left versus right comparisons may be appropriate (for example, paralysed hemidiaphragm, unilateral pneumothorax, unilateral empyema). Indeed, Elshafie and colleagues have used SLP to demonstrate left-right differences in breathing mechanics following lung resection[11]. However, the grid is more commonly divided into the thoracic and abdominal regions. Following this, both the relative thoracic/abdominal contribution and the phase angle (thoracoabdominal synchronicity) can be determined. Phase angle ranges from 0° (fully synchronous) to 180° (fully asynchronous or "paradoxical") (Figure 3).

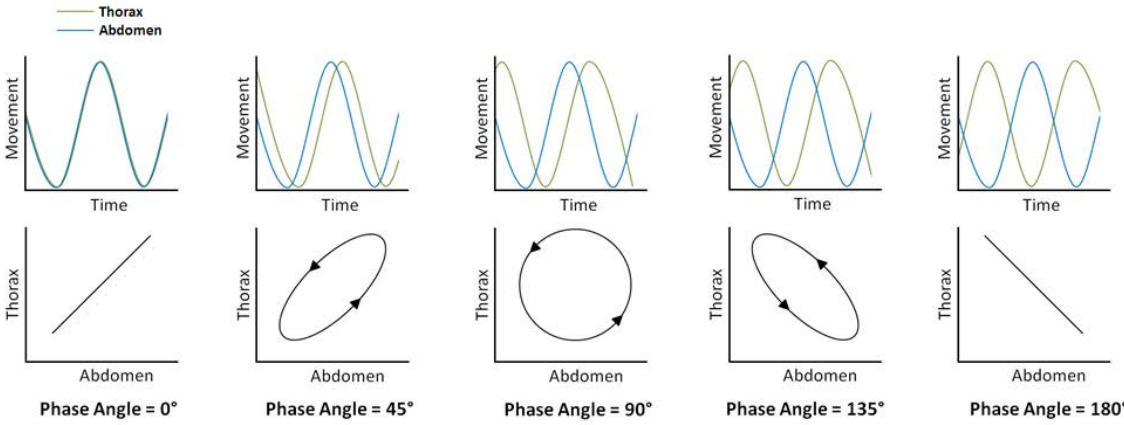


Figure 3: Graphs showing differing degrees of thoracoabdominal synchronicity. The top graphs show thoracic and abdominal movement over time and the corresponding Konno-Mead plots are shown below.

A pilot study by our research group has shown that both thoracic/abdominal contribution and phase angle are likely to be useful clinical markers of abnormal breathing mechanics in neuromuscular disorders[12]. In addition, we have observed that SLP is generally easy to perform in this group of patients, who often struggle to obtain traditional lung function and muscle function tests (apart from sniff nasal inspiratory pressure) due to their inability to maintain an air-tight seal around the mouthpiece (*unpublished data*). Because of this, comparing SLP data to routine lung function is difficult, although our preliminary data suggests that SLP could be used as a surrogate marker of inspiratory muscle strength in patients with Pompe disease[13]. We have also shown that SLP can be obtained in 100% of patients with Alström disease (74% obtain both seated and supine results), whereas only 39% achieve spirometry (± lung volumes and gas transfer) (*unpublished data*).

There has also been some interest in assessing the shift in breathing mechanics from a seated to a supine position. Increases in abdominal contribution and phase angle were observed in healthy individuals[14] and these effects were more pronounced in patients with airflow obstruction secondary to alpha-1 antitrypsin deficiency[14]. It seems logical to suggest that similar effects could be observed in patients with neuromuscular disorders, although this has yet to be investigated.

One major limitation of SLP is that its parameters do not yet have robust reference ranges, although they are currently in development and some preliminary ranges have been produced[15]. Also in development is a method for assessing respiratory entropy, which may be particularly useful for characterising dysfunctional breathing and assessing the effects of breathing retraining. Data analysis can also be challenging in some patients, particularly those with a variable breathing pattern. In these cases, the SLP will often fail to produce IE_{50} readings and, less commonly, relative thoracic/abdominal contribution (although this can be assessed visually from the Konno-Mead plot). The software also only allows one section of tidal ventilation to be analysed (rather than using markers to eliminate erroneous data), which can limit the outputs or result in the need for a repeat measurement. Despite these restrictions, SLP is has a number of major advantages due to its non-contact and radiation-free hardware, quick set-up, and simple software that allows for rapid full body or regional analysis.

CONCLUSIONS

SLP is a non-contact method for assessing breathing mechanics that can be used in almost every patient and respiratory disorder. It is still a relatively new technology and full publications are limited. However, there is an increasing amount of emerging data supporting its clinical utility in respiratory physiology, particularly for patients who cannot obtain traditional lung function tests.

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Perspective of a novice Respiratory Physiologist (from study to practice)

Raveena Chahal

Cardiorespiratory Unit

George Eliot Hospital NHS trust

Background: The role of a Respiratory Physiologist includes performing a range of diagnostic tests to aid diagnosis or monitor disease progression over a range of patients and conditions. These can include: pulmonary function tests, bronchial provocation challenge testing, blood gases, haemoglobin testing, respiratory muscle function testing, skin prick testing, full polysomnography, overnight oximetry, field exercise tests, long term oxygen therapy and other tests dependent on the grade of the practitioner. These tests also require interpretation however; this is determined by the experience and grade of the healthcare professional.

Student experience: As a student I completed 250 days of placement on the BSc healthcare science (Respiratory and sleep physiology degree). The clinical setting allowed me to observe how healthcare professionals interacted with patients and also other members of staff. Research has proven that interactive learning is beneficial. Students can find it difficult to link theory to practice. Exploring the situation and using reflection, can aid the transition to practice (Collingwood., 2005). During learning as a student the relationship between the supervisor is important as the supervisor acts as a positive role model. The knowledge and experience shared with the student is essential to their learning. To work closely with staff members and clinical teachers allows students to observe and reflect in the way their seniors adapt to a complex and changing clinical environment (Brown, Williams and Lynch., 2013).

I completed 250 days of my clinical placement across two different hospitals. I felt like I had gained invaluable experience by experiencing different ways of working and understanding the different systems used within various hospital settings. The layouts and different software used was suited to each individual requirements of the department. The initial interaction between team members in a department causes you to form perceptions. During clinical tests, assessments are performed. I felt that in my role as a student it was very important to retain knowledge from the lectures as these were applied to clinical practice.

During initial training within clinical practice, patient interaction is always observed and assessed by an appropriate mentor. Once a pulmonary function test is complete, a qualified physiologist analyses these results commenting on areas that can be improved. This is essential as a student as it allows you to improve your practice. As a student you become more confident as your knowledge and confidence in the hospital setting changes. A part of the portfolio for the practitioner training programme includes writing reflections. It is important to build self-awareness and consider the thought process behind reaching a decision. This awareness becomes more evident to other healthcare professionals observing as different patients are encountered.

Role as a healthcare professional. My exposure to different clinical tests made the transition from the completion of my degree and placement to work as a healthcare professional a gradual positive change. The introduction of different equipment was less daunting as I had been exposed to different equipment during my placements. As a newly qualified healthcare professional the departmental protocols must be adhered to leading to delivery of quality patient care. These protocols must be followed in making patient decisions. I understood my role and responsibilities to the patients and the hospital. The hospital has a framework based on core values and principles which must be respected.

Once competence was gained in performing tests on the departmental equipment, other diagnostic tests were introduced. As a new healthcare professional it was very important to develop my knowledge further. As I began developing my skills for interpreting different diagnostic tests, I was able to receive constrictive criticism from my superior leading to better practice. My interpretation of results obtained initially had been reviewed and either approved or advice was given on how to modify my results analysis. The communication between team members allowed effective healthcare delivery to patients and allows professionals to perform in their roles effectively (Babiker *et al.*, 2014). It became a part of my responsibilities to monitor and order accessories that patients would require due to the range of equipment issued by our services. I began to attend respiratory discussion conferences allowing continual professional development.

Despite completing my degree, learning doesn't just stop there. I recently attended the ARTP blood gas sampling course and undertook their portfolio of competence. The portfolio allows practitioners to gain recognised competence in performing and interpretation of capillary blood gases.

As a Respiratory Physiologist, the underpinning knowledge and performance of pulmonary function tests is essential in order to aid patient diagnosis and future management of their condition. As allied healthcare professionals we play a vital role within the patient care pathway and have a duty to our patients to maintain high quality standards of care, not only to perform and obtain good quality results from our patient but to listen and assist them along their way to help then feel at ease it what can sometimes be a stressful environment. The ARTP practitioner exam leads a recognised qualification. My aim is to gain competence and work towards gaining these certificates.

There are however different routes that can be pursued to become a Respiratory Physiologist. These include; undertaking training following a BSc degree and new apprenticeship schemes. All healthcare practitioners are adapting and changing throughout their professional career. With the introduction of new technology and research we must seek to provide the best possible care for patients.

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Inspiring a new generation of Physiologists

Ansel Godinho

Great Ormond Street Hospital for Children NHS Foundation Trust

In order to promote STEM (Science, Technology, Engineering and Math) careers, events are being held to showcase the professions. This year the NHS turned 70 and as it has developed there are more scientific professionals providing a role in the diagnosis and treatment of diseases.

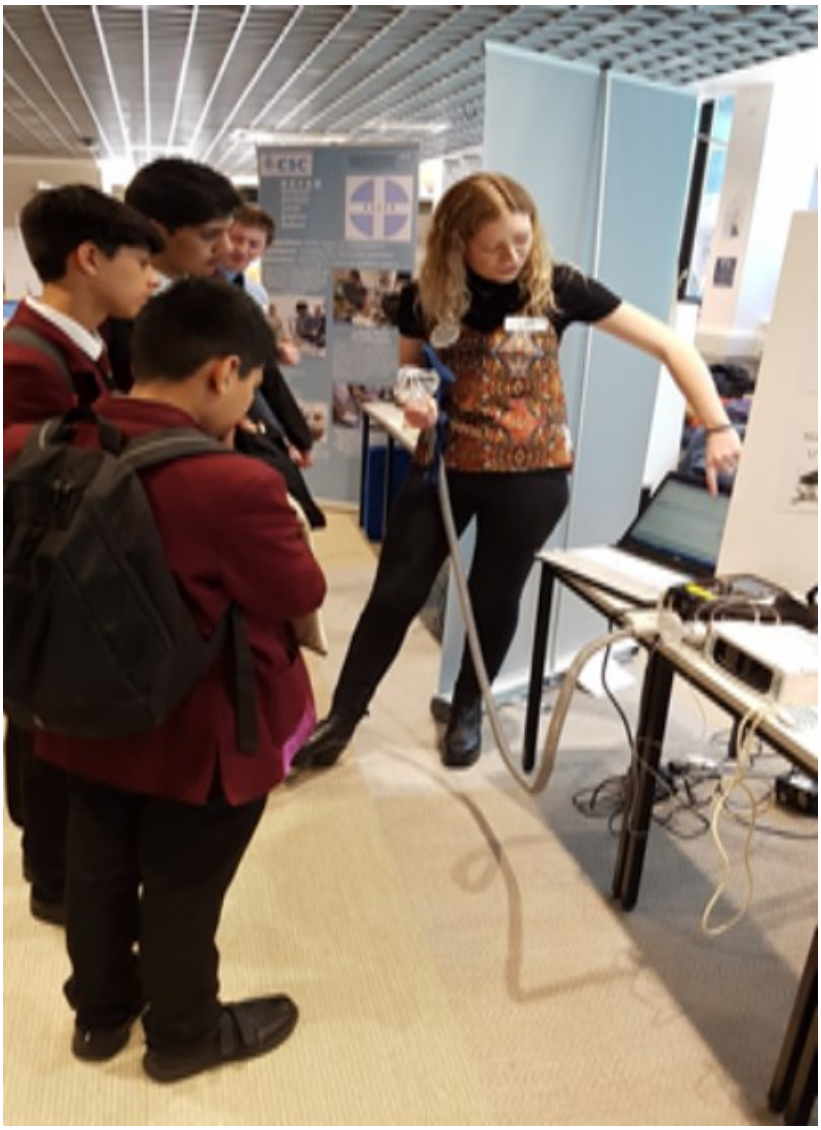
The newly created Healthcare Scientist group covers disciplines such as microbiology, biochemistry, immunology, physiology and many more. With financial constraints and technological advances the role of healthcare sciences is changng and cutting edge treatments and diagnostics are required to treat a growing and aging population.

One of the events is the Science4u annual schools science conference held at the University of Westminster. For the past 15 years the conference has promoted scientific careers to school children in London aged 13-15 from underprivileged backgrounds. In recent years our Sleep and Respiratory departments have held an interactive stand promoting our careers to these children. We aim to demonstrate our profession and hope this will inspire the attendees to consider a career in healthcare science.

Schoolchildren attend with their teachers to this interactive conference consisting of lectures, seminars and a careers exhibition. We ran demonstrations of polysomnography, pulse oximetry, end tidal CO_2 monitoring, non Invasive ventilation and spirometry. We also explained the different pathways that we have taken to enter into our professions.

Spirometry and non Invasive ventilation were the most popular exhibits on our stand. Attendees were excited by the practicality of our careers. Most of the students were already interested in pursuing a career in science, so to combine that with healthcare and the prospect of working directly with patients was seen as a big bonus. Many had not heard of clinical physiologists; when asked about careers they associate with hospital the most common were nurse or doctor. We explained that respiratory clinical physiologists provided an essential role in the diagnosis and treatment of respiratory conditions which impact a large population of the country.

Sleep in particular is an evolving field and with more and more consumer gadgets being released with sleep trackers it



is a hot topic in healthcare. However not many of our attendees know about it as a profession or the different conditions associated with poor sleep. Therefore in the short time they visited our stand they were given a snap shot into the world of sleep medicine and some were considering undertaking work experience in the field to learn more.

We had some big interest in all the interactive elements of our stand with many of the pupils thinking of a job in physiology as a future career. This annual event has now become a permanent fixture in our calendar and we are already planning next year's stand to continue endorsing respiratory and sleep physiology with the hope to inspire a new generation of clinical physiologists

Harry Griffin

Top Forum

Any hints or tips for using the Pulsox-300i for paediatrics? (15/10/2018)

The question: Advice was sought on using the Konica Minolta Pulsox-300i for overnight sleep recordings in paediatrics.

The responses: Initial responses were critical of the use of pulse oximetry as a standalone test in paediatrics. However, one reply suggested pulse oximetry has a place in paediatrics for detecting nocturnal hypoxaemia in neuromuscular or cardiac disorders. This physiologist and another suggested multichannel sleep studies should be used rather than pulse oximetry alone. Indeed, this view was supported by a senior paediatric physiologist who explained pulse oximetry alone was routinely used in their department to investigate sleep disordered breathing but as with adults a multi-channel sleep study is required to rule out sleep disordered breathing.

Result reporting query (04/10/2018)

The question: A physiologist raised concerns that members of their team had been using different criteria for interpreting the level of airflow obstruction.

The responses: This is a topic that has long concerned the physiology community and it is well known that interpretation of lung function varies between and within departments. A useful reply on the forum discussed how using the LLN to identify airflow obstruction is the best approach as recommended by ARTP. The physiologist pointed out that although grading the severity of airflow obstruction based on % predictive has its limitations, it is supported by both NICE and GOLD and thus predominantly used by clinicians.

ARTP toolkit (05/11/2018)

The question: Has anyone else received or had experience of the GIRFT programme and the ARTP toolkit? This initial question triggered the start of a lengthy discussion on the Forum discussing the aims of the GIRFT and how to complete the ARTP toolkit.

The responses: The first reply from the chair of ARTP explained that following concerns about shortfalls in the respiratory and sleep workforce as identified via the ARTP workforce survey, all Trusts were being asked to complete the ARTP toolkit as part of the GIRFT. He believed the aim was not to benchmark trusts but rather support the workforce to perform diagnostics tests within the 6 week target. However, this was later refuted by another physiologist who provided an email from the GIRFT review team that stated "The information received will form part of your Trust's Respiratory Medicine data pack, and will be benchmarked against the other 136 Trusts." Nonetheless, the chair stressed the importance of completing the toolkit as its most likely outcome would be to support the respiratory and sleep scientific workforce for the future. Over the next two weeks there were numerous questions regarding how to complete the toolkit which were kindly answered by Keith Butterfield who produced the toolkit.

New evidence: Pre-operative spirometry is safe in thoracic aortic aneurysms! (05/11/2018)

The question: Not a question as such, but a previous President of ARTP brought a useful publication to the attention of the forum. Frost *et al*., 2018 recently published a paper in the ERJ demonstrating spirometry is not a contraindication in aortic aneurysms. It was suggested that this

evidence further supported data published earlier in the year from the Royal Brompton that showed a high level of safety of performing lung function tests (Roberts *et al.*, 2018).

Frost, F., Peat, R., McWean, J., Shaw, M., Field, M., Nazareth, D., Walshaw, M. Pulmonary function testing is safe in patients with thoracic aortic aneurysms

Eur Respir J 2018 52: p. 1800928-1800928

Roberts, Cara & Ward, Simon & Walsted, Emil & Hull, James. (2017). Safety of pulmonary function testing: Data from 20 years. Thorax. 73. thoraxjnl-2017. 10.1136/thoraxjnl-2017-210246.

Arnold Chiari Malformation (03/12//2018)

The question: I have been asked if I am willing to perform PFT s on a patient who has Arnold Chiari Malformation?

The responses: Two senior physiologists responded by stating they were unaware of any contraindications for performing lung function tests. It was discussed that the main respiratory concern was central hypoventilation and that a sleep study is commonly performed in children as they may require NIV.

7 day working (05/12/2018)

The question: Following a request from hospital management a physiologist asked the forum for some advice on how 7 day working could work....or not work.

The response: Just one response, but a detailed one from a former president of ARTP and current president of the Academy of Healthcare Science. The physiologist was recommended to ask her management team to provide a business plan and evidence to show that 7 day working for a lung function department would be cost-effective or improve patient care. It was suggested that 7 day working would require extra resources such as, staff, equipment and A&C support. Without these additional resources working hours in the Monday-Friday service would need to be reduced.

Furthermore, a change in hours of the current staff would require involvement from employment processes to ensure that no staff are constructively dismissed or discriminated against. Finally, an alternative solution could be to have longer working days with staff working a 4 day week.

Oesophageal varices 18/12/2018

The question: Is anyone aware if oesophageal varices are a contraindication for spirometry?

The response: Some very useful advice from two senior physiologists. The consensus was that a decision needs to be made on a case by case basis as the risk to bleeding varies greatly. If the risk is high but the patient is being considered for surgery then the minimum number of tests to get clinically useful results should be performed. The importance of using filters was highlighted due to increased infection risk from these patients having open wounds in the oesophagus.

Medical air 30/01/2019

The question: Following a 'Never Event' where a patient was connected to air instead of oxygen, this physiologist asked whether other departments have medical air pipelines and what safety measures they have in place.

The response: One useful reply described how flowmeters were never left attached to piped air and the outlets were physically separated from the oxygen points by about four feet and the wall behind the outlets painted a different colour to the standard walls.

Glasgow 2019


ARTP
Association for Respiratory Technology & Physiology
ARTP
GALA Dinner 2019
ARTP
Glasgow 2019
31st January – 1st February
"They were so fixed in their idea that the
have an oxygen tube. It seemed
suggestion. I was absolutely appalled. This
hopeless way of going about things and I reckone
that we could do much better!"

Chair:

Dr. Karl Sylvester

ARTP AGM Minutes

Thursday 31st January 2019

Lord Provost Room, Double tree by Hilton Hotel, Glasgow Central

ARTP Association for Respiratory Technology & Physiology

- Dr Karl Sylvester (KS), ARTP Honorary Chairman, welcomed the audience that was more than 100 people and outlined the agenda for the AGM and the annual report that had been sent to all members prior to the AGM.
- KS introduced all the Executive Board Members and thanked the Council Members for their work this year.
- Membership numbers continue to grow with 98 new members in 2018-19 and an increase in ARTP sleep members.
- Mike Lang (ML) gave an overview of the accounts where there has been a small increase in income and expenditure with a stable surplus of income over expenditure. Any surplus will be reinvested in any education and training. KS overviewed the membership categories that have voting rights (allied, associate or life member). Approximately 110 members voted to accept the accounts with no objections.
- The role of Vice Chair was up for election and it was proposed the Joanna Shakespeare would take on this role. The membership of approximately 110 voted in favour of this with no objections so the nomination was accepted.
- Mike Lang was standing for another term as treasurer. The membership accepted this nomination with no objections.
- KS outlined further committee changes with a new Sleep Chair (Sara Parsons), Education Chair (Vicky Moore), Education Vice Chair (Ed Parkes), Spirometry Chair (Jo Purvis), Research Chair (Jamie Stockley), Standards Vice Chair (Peter Moxon) and Examination Chair (Helen Purcell). KS welcomed any new volunteers to the ARTP to get in touch.
- KS gave an overview of the work the ARTP has been involved in over the last year particularly the Taskforce for Lung Health with the aim to deliver on recommendations to have an appropriate workforce to diagnose, treat and care for people with long disease.
- Chris Jones (CJ) gave overview of the new website as the existing site cannot be further developed due to software limitations. The new website, due to go live in April/May 2019, would make it easier to renew membership and book onto course and the conference. Members will be sent email with details to log into their details.
- KS outlined the benefits of ARTP membership including joint membership with ERS and BSS as well as discount on courses and the conference. In 2019 there will be more free to attend CPD courses starting with a CPET forum and expanding to include Sleep Scoring.
- KS thanked the Board, Council and Committee members for their input over the last 6 years as well as EBS for the work they do on behalf of the ARTP. He thanked Kelly Pauley for her hard work to put the conference together.
- KS announced the 2020 conference will be in Birmingham Hilton Metropole.
- KS asked if there were any questions from the membership – Vicky thanked KS for his input into the new spirometry assessment process.
- KS bought the AGM to a close.

ARTP conference 2019

Thursday 31st January - Friday 1st February 2019

Doubletree by Hilton, Glasgow Central

ARTP Association for Respiratory Technology & Physiology

Accepted abstracts

Click on the Abstract Number (#) to view the abstract

O = Oral, P = Poster, TP = Thematic Poster

#	Author(s)	Title
O1	Bryce M	OPTIMIZING RESPIRATORY PHYSIOLOGY SERVICES: DIRECT ACCESS PHYSIOLOGIST LED CLINIC – A SERVICE EVALUATION
O22	Lawrence P	A PROSPECTIVE AUDIT OF EXHALED NITRIC OXIDE USE IN PAEDIATRIC ASTHMA MANAGEMENT
O29	Thomas M	CPET: WHEN PEAK VALUES CAN BE MISLEADING AND WHY GRAPHICAL PRESENTATION IS CRUCIAL
O41	Thomas A	THE VARIANCE IN RESPIRATORY DISTURBANCE INDEX IN PACEMAKER PATIENTS
P2	Clough D	A COMPARISON OF THREE DIFFERENT ALGORITHMS FOR ESTIMATING PEAK OXYGEN UPTAKE WITH THAT MEASURED DURING CPET IN A SURGICAL POPULATION
P4	Gaspar A	IMPACT OF REMOTE MONITORING FEATURE FOR CPAP THERAPY – A SERVICE AUDIT
P9	Thomas M	TEMPORAL TRENDS IN CARDIOPULMONARY EXERCISE TESTING (CPET) SERVICE UTILISATION
P11	Chahal R	THE EFFECT OF RESPIRATORY TRAINING USING POWERBREATHE ON ASPECTS OF RESTING LUNG FUNCTION AND PREDICTED VO2 MAX
P13	Dobson E	A COMPARATIVE ASSESSMENT OF THE RELATIONSHIP BETWEEN MEASUREMENTS MADE IN AN INCREMENTAL SHUTTLE WALK TEST AND AN INCREMENTAL CYCLE ERGOMETRY TEST IN PATIENTS WITH IDIOPATHIC PULMONARY FIBROSIS
P18	Heath R	CASE STUDY: CARDIOPULMONARY EXERCISE TESTING (CPET): RELATION TO SURGICAL PATHWAY AND PATIENT OUTCOMES
P19	Irving S	CURVILINEARITY (CURV) IN HEALTHY CHILDREN AND THOSE WITH CYSTIC FIBROSIS
P21	Kendrick A	PREDICTING HRMAX IN PATIENTS ON B-BLOCKERS. CHOOSING THE RIGHT EQUATION DURING CARDIOPULMONARY EXERCISE TESTING
P24	Lawrence P	EVALUATION OF LUNG FUNCTION TESTING IN CHILDREN WITH SICKLE CELL DISEASE
P27	Parkes E	PREVALENCE OF RESTRICTIVE SPIROMETRY IN PATIENTS WITH ADULT CONGENITAL HEART DISEASE (ACHD)
P30	Van Ristell H	THE UTILITY OF NIV IN MND PATIENTS WITH BULBAR SYMPTOMS

P33	Glover R	DETERMINING THERAPEUTIC CONTINUOUS POSITIVE AIRWAY PRESSURE USING AUTO CPAP DEVICES OR ESTIMATES BASED UPON SEVERITY
P35	Kendrick A	CLOSE ENCOUNTER OF THE MORPHINE KIND? WHEN TELEMEDICINE WOULD HAVE BEEN REALLY USEFUL - A CASE REPORT
P36	Laverty A	WHAT IS AN ADEQUATE DURATION FOR A RESPIRATORY SLEEP STUDY IN CHILDREN WITH NEUROMUSCULAR DISORDERS?
P38	Parsons S	ARE SUBJECTIVE OUTCOMES INFLUENCED BY THE USE OF HUMIDIFICATION?
P40	Pearson J	SCREENING AND DIAGNOSIS OF OBSTRUCTIVE SLEEP APNOEA IN PREGNANCY

TP3	Earle C	AN EVALUATION OF SPIROMETRY TRAINING
TP5	James A	A COMPARATIVE STUDY OF COUGH PEAK EXPIRATORY FLOW (CPEF) USING FULL FACE MASK VS MOUTHPIECE INTERFACES IN HEALTHY SUBJECTS
TP6	Russo K	HYPOXAEMIA FROM USING AN ADULT OXYGEN FACE MASK IN A PAEDIATRIC PATIENT
TP7	Macleod J	EARLIER USE OF FRACTIONAL EXHALED NITRIC OXIDE (FENO) AND CHALLENGE TESTING IMPROVES SPEED AND ACCURACY OF ASTHMA DIAGNOSIS
TP10	Walton L	A SERVICE AUDIT ON THE UTILISATION OF PULMONARY FUNCTION EQUIPMENT WITHIN THE RESPIRATORY PHYSIOLOGY LABORATORY
TP15	Gidden L	PULMONARY FUNCTION AND HEALTH STATUS IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE
TP16	Gregory B	CAN PEAK CIRCULATORY POWER BE PROGNOSTICALLY USEFUL IN PATIENTS UNDERGOING ABDOMINAL AORTIC ANEURYSM REPAIR SURGERY? A PILOT STUDY
TP17	Hawkes S	DYSFUNCTIONAL BREATHING: MAKING A DIAGNOSIS AND EFFECTIVE SYMPTOM MANAGEMENT IN A DISTRICT GENERAL HOSPITAL.
TP20	Jess L	AN EVALUATION OF REFERRAL SOURCES AND PATIENT OUTCOMES FOLLOWING PHARMACOLOGICAL BRONCHIAL CHALLENGE TESTING IN NHS LOTHIAN
TP23	Lawrence P	EVALUATION OF HYPOXIC CHALLENGE TESTING AND ITS USES IN CHILDREN AND YOUNG PEOPLE
TP25	Moore V	PREDICTORS OF PATTERNS OF RESPONSE FOLLOWING SPECIFIC INHALATION CHALLENGE TESTING WITH LOW MOLECULAR WEIGHT AGENTS
TP26	Moore V	IDENTIFICATION OF SIGNIFICANT LATE REACTIONS FROM SMALLER EXPOSURES IN SPECIFIC INHALATION CHALLENGE TESTING
TP28	Rogers J	HEALTH RELATED QUALITY OF LIFE IN PATIENTS WITH DYSFUNCTIONAL BREATHING REFERRED TO A CARDIOPULMONARY EXERCISE TESTING SERVICE
TP31	Davies S	EVALUATION OF PHYSIOLOGIST LED SLEEP APNOEA CLINIC
TP32	Engleman H	A COMPLEX SLEEP APNOEA CASE: ROLE OF ENHANCED TECHNOLOGY AND REMOTE MONITORING
TP37	Mattu D	COMPARING DIAGNOSTIC ACCURACY OF AUTOMATED SCORING FOR NOX T3 LIMITED MULTICHANNEL SLEEP STUDY WITH PHYSIOLOGIST HAND SCORING.

OPTIMISING RESPIRATORY PHYSIOLOGY SERVICES: DIRECT ACCESS PHYSIOLOGIST LED CLINIC—A SERVICE EVALUATION

Melanie Bryce. North West Anglia NHS Foundation Trust

Background: In a move to reduce inappropriate Chest Clinic referrals and waiting list times, a direct access physiologist-led service was introduced. Since its introduction in 2010 the service has grown significantly. The clinic acts as an intermediary to provide support to GPs in the diagnostic classification of lung defects, and advises how best to manage these conditions in primary care. This is all under the clinical supervision of a consultant chest physician without the need to refer to a consultant-led clinic in the first instance.

The service consists of a full clinical history, quality assured pulmonary function testing (spirometry, gas diffusion and static lung volumes) and airway reversibility testing where airflow obstruction or evidence of small airway disease is observed. A comprehensive report is reviewed by the consultant physician and sent electronically to the referrer. In the event that an onward Chest Clinic referral is required, it was agreed that the cost of the services should deducted from the Chest Clinic tariff – resulting in an at least cost neutral service.

The Aim of this study was to review retrospectively service demand and patient outcomes over an 8-year period since the commencement of the direct access physiologist led service.

Methods: A retrospective data analysis and case review was conducted between 20/09/2018 and 28/09/2018 using the cohort of 633 subjects over an 8-year period from a single centre direct access physiologist led database.

Results: Of the 633 patients who were referred directly into the direct access physiologist led service, 453 (71.5%) patients were discharged with recommendations of onward management in primary care. 15 (2.3%) patients were referred to another service (ENT, Cardiology, Pulmonary Rehabilitation) and 9 (1.4%) had a Chest Clinic appointment already in place. 148 (23%) patients required onward Chest Clinic referral. Of the 453 patients that were returned to primary care only 1 subject was re-referred to Chest Clinic within a 6-month period.

Conclusion: The direct access physiologist-led service provides a safe and effective service whilst significantly reducing the demand on new patient chest clinic appointments. 71.5% of patients who used this service have subsequently been managed within primary care, resulting in a significant saving to the health economy. Evaluation of patient outcomes showed a <1% re-referral rate to Chest Clinic once returned to the management of primary care within a 6-month period. Two advanced physiologists have now completed formal training in clinical examination and have been assessed by the overseeing consultant physician to develop this service further.

A PROSPECTIVE AUDIT OF EXHALED NITRIC OXIDE USE IN PAEDIATRIC ASTHMA MANAGEMENT.

Philip Lawrence. Alder Hey Children's Hospital, Liverpool

Background: Exhaled nitric oxide (FeNO) measurements can guide asthma management in children to reduce exacerbations. However, current evidence does not support its routine use and further data are required (Petsky HL *et al*, Cochrane Database of Systematic Reviews 2016).

Aims/Objectives: To assess: (i) feasibility of FeNO testing in children attending tertiary asthma clinics; (ii) respiratory specialist's opinion about the influence of FeNO on management; and (iii) correlation of FeNO levels with lung function and serum eosinophils.

Methods: Prospective audit of FeNO measurements (ppb), spirometry (GLI, % predicted), clinician opinion regarding influence of FeNO levels on management decisions, frequency of reporting FeNO measurements in written clinic correspondence and serum eosinophils (%) (if within 2 weeks of FeNO measurement). Spearman's Rank Correlation and Kruskal Wallis H tests were used for statistical analysis and $p<0.05$ was considered significant. Ethical approval was not required for this clinical evaluation.

Results: 167 readings were taken from 106 patients (see table 1). Clinicians found the measurements useful in guiding management decisions 28% of the time and recorded the reading in the clinic letter 60% of the time. Statistically significant correlations were seen between FeNO measurements and FEV_1, $MEF_{25/75}$ and FVC/FEV_1 ratio (all $p<0.001$). No significant correlation was seen between FeNO levels and serum eosinophils, but numbers were small (n=22).

Conclusions: FeNO testing is feasible in young children and this non-invasive test appears useful in guiding management in some asthmatics. Further data are required on the correlation of FeNO measurements with other markers of asthma control.

Table 1:. Descriptive Statistics

n	169
% Males	55.6%
Age (years)	12.5 (4.7-17.0)
FEV_1 (L)	2.03 [1.51-2.55]
FEV_1 Pred (%)	84.0 [72.8-95.3]
FEV_1/FVC Ratio (%)	77.14 [69.73-84.55]
$MFEF_{25/75}$ (L/s)	1.70 [1.11-2.29]
$MFEF_{25/75}$ Pred (%)	60.0 [39.7-80.3]
FeNO (ppb)	45 [10-80]

Median (range) or [Interquartile Range]

CPET: WHEN PEAK VALUES CAN BE MISLEADING AND WHY GRAPHICAL PRESENTATION IS CRUCIAL

M. O. Thomas. University Hospitals Birmingham

Background: A 78 year old male attended for pre-operative assessment for an abdominal aortic aneurysm repair. The aneurysm was discovered through screening and he has no past medical history of note. He is prescribed atorvastatin and aspirin. He is an ex-smoker with a smoking history of 5 pack/years. His BMI is 24.7. His self-reported activity levels are high – he plays golf twice a week (full 18 holes with carrying his own clubs), walks a few miles daily, and uses his exercise bike in the home. As part of the pre-operative assessment, spirometry and incremental work-rate cardiopulmonary exercise testing were performed within the respiratory department. The remainder of the workup for surgery included basic observations, a 12-lead ECG, a transthoracic echocardiogram, CT of the thorax and abdomen, a full blood count, and anaesthetic review.

Assessment: Spirometry showed mild obstruction [FEV_1 of 102% predicted (2.8 L); FVC of 128% (4.74 L); FEV_1/FVC ratio 59.4%].

CPET showed a normal aerobic capacity (VO_2peak = 21.1 ml/min/kg; 95% predicted) with normal VO_2 at the metabolic threshold (11.8 ml/min/kg; 53% of predicted VO_2max). HR at peak exercise reached predicted (142 bpm; 100% predicted) as did oxygen pulse (11.3 ml; 97% predicted). BP response was appropriate. ECG was in sinus rhythm throughout with no change in ST-segment. The test was symptom limited and the reason for termination was bilateral leg fatigue. The patient denied symptoms of chest pain or dizziness. The only abnormalities with the CPET were an upward deflection of the HR/VO_2 slope, a slight down-sloping of the oxygen pulse and a decrease in the relationship between VO_2 and work-rate. These findings can indicate cardiac abnormality specifically ischaemia or mitral valve disease. However, with no ST-segment changes, chest pain, haemodynamic changes, and normal peak values this distinction requires careful analysis of graphical data.

The echocardiograph was reported as normal with some trivial mitral valve regurgitation (MR). There were no notable observations from the other assessments.

Due to the CPET report, a stress echocardiograph was performed. It showed trivial MR at rest and moderate-severe MR at 60% of maximum heart rate.

Conclusion: Graphical CPET data provided insight to pathology where peak values and other assessments were normal. CPET interpretation requires careful analysis of graphical data, but when utilised effectively, it offers insight to the dynamic changes from rest to peak exertion.

THE VARIANCE IN RESPIRATORY DISTURBANCE INDEX IN PACEMAKER PATIENTS

Alexander Thomas. Royal Brompton Hospital, London

Background: The burden of obstructive sleep apnoea (OSA) in adults is estimated at around 3-7% globally and 2-3 times greater in patients with cardiac disease. Standard practice in the UK for diagnosing OSA is to conduct a single-night sleep study. However, several studies have indicated that measured OSA severity may not be consistent across consecutive nights, highlighting potential weakness in the sensitivity and specificity of single-night studies with implications for the treatment pathway of patients. The purpose of this retrospective study was to use the sleep apnoea monitoring (SAM) function of pacemakers as a novel way to investigate the variability of OSA severity across consecutive nights, in pacemaker patients with suspected OSA.

Methods: 61 subjects, 34 male (age 76±10) and 27 female (age 80±13.6) were selected from the pacemaker patient databases within an NHS Foundation Trust. The respiratory disturbance index (RDI), a surrogate for apnoea/hypopnoea index measured by assessing disturbances to the transthoracic impedance-derived minute ventilation feature of the pacemaker, was obtained for the 14 nights preceding each subject's most recent pacemaker interrogation. Statistical tests in SPSS were then used to assess the variability of within-subject RDI and RDI severity (<20 = 'non severe', >20 = 'severe') over the 2 weeks.

Results: Intraclass Correlation Coefficient suggested 'good' agreement between within-subject RDI score categorisation over the 14-night period. A Kappa value of 0.55 suggested 'moderate' agreement between within-subject measured severity of RDI across the 14 nights. There were non-significant differences in between-subject RDI across the different nights at a 95% confidence interval ($p = 0.07$). Bland-Altman plots showed considerably large 95% confidence interval ranges between night 1 RDI and each subsequent night with a large scattering of values in each plot. 49.2% of patients changed their RDI severity on at least 1 subsequent night from their severity on night 1. There was a 16% probability of misclassification of RDI severity using only the RDI values from the first night.

Conclusions: Despite good agreement between absolute RDI values across the 14 nights, there was demonstrable variability in the measured severity classification of RDI within-subjects between nights. The probability of misclassification of RDI severity from a single night being 16% is consistent with previous research. This highlights the need for closer scrutiny of patients with cardiac disorders who are scored as negative or mild OSA on single-night sleep studies and would possibly therefore not be considered for CPAP therapy or other first-line interventions.

A COMPARISON OF THREE DIFFERENT ALGORITHMS FOR ESTIMATING PEAK OXYGEN UPTAKE WITH THAT MEASURED DURING CPET IN A SURGICAL POPULATION

David Clough. Wrexham Maelor Hospital

Objective: Validity of predictive algorithms in a surgical population has not been established (Ahmadian HR *et al* 2013). The suggestion is that exercise capacity in a general surgical population tends to be overestimated by these equations (Levett DZH *et al* 2018). We compared 3 different equations for estimating exercise capacity with that measured during a cardiopulmonary exercise test (CPET) performed using a cycle ergometer. The null hypothesis was that algorithms do not overestimate exercise capacity in a surgical population.

Methods: The study was retrospective. There were 107 subjects over a period of a year beginning February 2014 to the end of January 2015 who each exercised on an electronically-braked cycle ergometer to the limit tolerance, using a continuously ramped incremental CPET protocol. The highest oxygen uptake (VO_2peak) in $mL.min^{-1}$ was measured using a metabolic cart. For each subject estimated exercise capacity was calculated using 3 different equations (Jones *et al* 1985 (JVO_2peak), Hansen *et al* 1984 (HVO_2peak), and Wasserman *et al* 1999 (WVO_2peak)). Differences between estimated VO_2peak and measured VO_2peak were assessed by comparing group means using two -sided paired Student's t-tests. The Betsi Cadwaladr University Health Board research and development department viewed it as a service evaluation, which did not require ethical approval.

Study population

	Mean (SD)
Age (years)	67.2 (13.0)
Sex (M/F)	73/34
BMI ($Kg.m^{-2}$)	28.0 (4.9)
FEV_1 (% predicted)	81.4 (21.2)

Of the 107 subjects 63 were having colorectal surgery, 16 upper gastrointestinal, 10 renal, 11 abdominal aortic aneurysm, 4 thoracic and 3 orthopaedic. Incremental phase test duration was on average 9.2 ± 2.4 minutes.

Results: The differences between all three equations for estimating VO_2peak and measured VO_2peak were statistically significant $P<0.001$ (Mean(95%CI) for VO_2peak 1505(47), JVO_2peak 1861(70), HVO_2peak 1931(67), and WVO_2peak 1863(45).

Conclusion: We reject the null hypothesis that algorithms do not overestimate exercise capacity in a surgical population.

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IMPACT OF REMOTE MONITORING FEATURE FOR CPAP THERAPY – A SERVICE AUDIT

Ana Gaspar. East And North Hertfordshire NHS Trust

Introduction: From August 2016 all patients starting CPAP therapy (Continuous Positive Airway Pressure) for the treatment of OSA (Obstructive Sleep Apnoea) within our service have been enrolled on a cloud based remote monitoring system. All therapy data is automatically accessible by the Sleep Team through an online platform and changes to treatment can be implemented remotely. We conducted a service audit to assess the impact of remote monitoring on our patient pathway and treatment compliance.

Method: We selected two groups of 30 patients starting CPAP therapy in July and August 2016 (without remote monitoring) and 2017 (with remote monitoring) and explored patient follow-up data to evaluate the impact on time to first intervention, time to achieve compliance and number of clinic visits until compliance was achieved.

We chose the same timeframe to minimize confounding factors such as temperature, which can affect compliance, and the holiday period, which can affect patient attendance.

Results: After remote monitoring was implemented, time to first intervention dropped from a mean of 20.4 days (median 15 days) to mean of 15 days (median 14 days), time to compliance also dropped from a mean of 34 days (median 15.5) to 23 days (median 14 days). We noted a drop in the mean number of clinic visits until compliance was achieved (1.44 to 1.1 visits) but the median remained stable at 1 visit.

Due to the small sample size, a power calculation was not completed.

Conclusion: There was a reduction in both median times (in days) to 1st intervention and to compliance. Remote monitoring allows for change in settings and targeted advice during the third day call, which would account for this improvement.

There was no change in the mean number of visits as, despite access to this feature, our patient pathway remained the same in terms of scheduled visits.

TEMPORAL TRENDS IN CARDIOPULMONARY EXERCISE TESTING (CPET) SERVICE UTILISATION

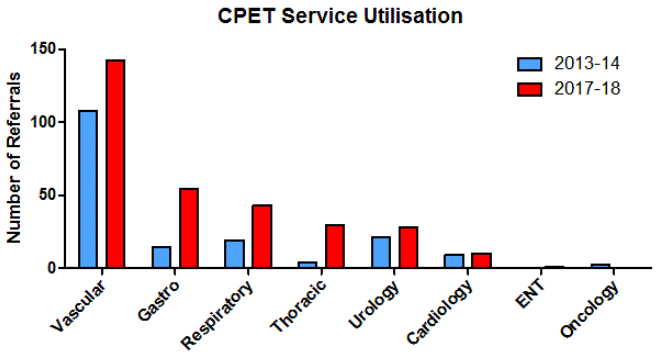
M. O. Thomas. University Hospitals Birmingham

Introduction: CPET is used as a preoperative screening tool to assess fitness; as a disease monitoring tool to determine functional limitation and treatment response; or as a diagnostic tool to identify the cause of breathlessness or exercise intolerance. A previous audit had identified that the service at Birmingham Heartlands Hospital was underutilised for diagnostic purposes.

Methods: We conducted a retrospective analysis of CPET referrals between 01/07/2017 and 31/05/2018, and compared with those of 01/07/2013 to 31/05/2014. The source of referral and clinical indication were recorded and presented.

Results: Total referrals for CPET were 307 in 2017-18 compared to 178 in 2013-14 (see figure) indicating a 72.5% increase. The majority of referrals were for surgical disciplines rather than medical disciplines in both time periods (253 vs 54 in 2017-18; 150 vs 28 in 2013-14); the proportion of tests for diagnostic purposes has remained the same (17.5% in 2017-18 vs 16% in 2013-14). Vascular surgery was the largest source of referrals in both time periods (46.3% in 2017-18; 61% in 2013-14). CPET referrals from thoracic surgery and gastrointestinal (upper GI and colorectal) surgery have increased proportionally (9.4% and 17.5% respectively in 2017-18; 2.2% and 5.6% in 2013-14).

Discussion: CPET offers a unique assessment tool for the investigation of patients with unexplained dyspnoea and can pre-empt invasive, expensive, and potentially unnecessary assessment without definitive diagnosis (Thing *et al*. Thorax 2011; 66 (4): A144). The CPET service has experienced large increase in the number of referrals since 2013. Vascular surgery remains the primary source of referral, but the service has seen an increase in referrals from thoracic, upper GI and colorectal surgery. However, there has been no proportional increase in the use of CPET for diagnostic purposes. The service is evidently growing, but more awareness needs to be raised to increase the utilisation of CPET in diagnosing the cause of breathlessness.



THE EFFECT OF RESPIRATORY TRAINING USING "POWERBREATHE" ON ASPECTS OF RESTING LUNG FUNCTION AND PREDICTED VO2 MAX

Raveena Chahal. George Eliot Hospital, Nuneaton

Introduction: Research on the effects of inspiratory muscle training (IMT) in healthy individuals is limited, but previous studies have indicated an effect on lung function in healthy individuals at a higher intensity of training. This study investigated the effects of IMT on VO_2max and lung function using the Powerbreathe device which is an inspiratory threshold loading device made in the UK. This device allows an increase in resistance tailored to each individual. The project was approved by the university's life science ethics committee.

Method: A comparative study was carried out on seven young healthy participants, four males and three females, between the ages of eighteen and twenty-eight. Lung function measurements were taken while the participants were seated and supine pre and post intervention of the Powerbreathe device. To evaluate VO_2max the Queens College Step test was utilised and the heart rate was monitored. Males were required to complete 24 steps/minute and females 22 steps/minute. This was completed for a total of 3 minutes. The volunteers were instructed to take thirty breaths twice daily for a period of four weeks. The subjects were encouraged to increase the resistance as they progressed through this period of IMT.

Results: The participants' VO_2max and forced expiratory volume in the first second (FEV_1) values before and after the training regime were compared using a two-tailed Wilcoxon-Mann-Whitney U test. There was no statistically significant increase in the VO_2max before and after training (where statistical significance is defined as $p<0.05$, $p=0.74896$). The VO_2max for males was calculated using the formula; (ml/kg/min) 111.3-0.42×heart rate (bpm), for females (ml/kg/min) = 65.81-0.1847×heart rate (bpm). There were no changes in FEV_1 seated before and after the training regime.

The lower quartile and upper quartile ranges before and after training were 2.9 to 3.7. Following training the range was 2.7 to 3.5. The IQR was calculated as 0.8 for these ranges pre and post. The median pre training was 3.3 and post training was 3.1.

Conclusion: These results do not support the use of the Powerbreathe device. The major limitation to this study was the small sample size. Further research is needed in healthy individuals.

A COMPARATIVE ASSESSMENT OF THE RELATIONSHIP BETWEEN MEASUREMENTS MADE IN AN INCREMENTAL SHUTTLE WALK TEST AND AN INCREMENTAL CYCLE ERGOMETRY TEST IN PATIENTS WITH IDIOPATHIC PULMONARY FIBROSIS

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Background: Idiopathic pulmonary fibrosis (IPF) causes lung function decline, exercise limitation and ultimately death. The rate of disease progression is variable but accurate prognosis aids clinical management. Cardiopulmonary exercise testing (CPET) is the gold standard prognostic test for IPF; peak oxygen consumption (VO_2 peak) and blood oxygen (PO_2) at peak exercise are known to be good indicators of prognosis. However, CPET is not routinely used to assess IPF. Incremental shuttle walk testing (ISWT) is quicker, cheaper and more widely available than CPET. Our previous work (Fielding *et al*. 2015) found a statistically significant relationship between distance walked in an ISWT (ISWTD) and VO_2 peak during CPET in patients with IPF.

Aims: This study examines the relationship between ISWTD and CPET VO_2 peak in a new cohort of patients with IPF. We will go on to compare the ISWTD-CPET VO_2 peak relationship in the current study with that in the previous study. In this way we aim to validate or challenge the relationship. In addition to work in the previous study, we will also test whether PO_2 is the same at the end of both ISWT and CPET and compare patient perception of the two tests in order to assess whether patients prefer one test over the other.

Methods: This study has received HRA ethical approval (details below). Recruitment continues. Each participant undertakes CPET and ISWT. PO_2 is measured at the end of the test and participants rate their perceived anxiety, embarrassment and discomfort. Statistical analysis of the relationship between VO2 peak and ISWTD is performed using a linear model and compared with previous study results. PO_2 values and questionnaire responses are analysed using paired t-tests.

Results: Disease-related functional impairment has limited recruitment. Six participants have completed both tests. Interim analysis indicates no difference between the VO2 peak-ISWTD relationships in this study and the previous one. Participants have reported no embarrassment and, at most, “some” discomfort and “very little” anxiety so far.

Conclusion: Provisional results support a positive and reproducible relationship between VO_2 peak and ISWTD. This suggests that ISWT should be used more widely to assess patients with IPF in order to improve prognostic predictions and patient care.

References: Fielding, R., Shakespeare, J., Woodhead, F., Hughes, R. and Parr, D. (2015) 'The relationship between the incremental shuttle walk test and the incremental cycle ergometry test in interstitial pulmonary fibrosis.'

HRA approval granted December 2018 by the London Bromley Research Ethics Committee, REC reference: 17/LO/1953. IRAS ID: 222072.

CASE STUDY: CARDIOPULMONARY EXERCISE TESTING (CPET): RELATION TO SURGICAL PATHWAY AND PATIENT OUTCOMES

Rachel Heath. University Hospital Of North Midlands

Introduction: Cardiopulmonary exercise testing (CPET) can be used to assess an individual's risk of undergoing major elective surgery. Poor exercise capacity is associated with an increased risk of morbidity and mortality.

This case study is on a lady who had a lesion in the tail of her pancreas, consistent with renal cancer metastasis. The pancreatic cancer appeared operable and the patient was keen for surgery. As part of her pre-operative assessment a CPET was requested to assess aerobic fitness.

The results of the CPET showed that she had increased risk (anaerobic threshold - 8.7 ml/kg/min) with anaemia (tHb 61 g/L) as the contributing factor. This finding was reported to the anaesthetic and surgical teams resulting in the preoperative management in the form of a blood transfusion. A repeat CPET was performed 21-days later (tHb 92 g/L).

Results: There was an improvement shown in VO_2 max, anaerobic threshold (AT) and VE/VO_2 following the blood transfusion.

Conclusion: The blood transfusion resulted in an increase in the patient's cardiovascular responses and is consistent with the threshold used within the perioperative pathway. The outcome of this was that the patient was able to have their distal pancreatectomy. Despite some complications in recovery the surgery was successful. This case study highlights the important role that respiratory physiology plays in a patient's pathway and outcome.

References:

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	CPET (tHb 61 g/L)		CPET (tHB 92 g/L)		Change
		% Pred		% Pred	
AT (mL/kg/min)	8.7	46	10.8	57	+20%
VO_2 max (mL/kg/min)	15.4	82	17.4	92	+11%
V_E/VO_2 (mL/min)	33	76	31	69	-6

CURVILINEARITY (CURV) IN HEALTHY CHILDREN AND THOSE WITH CYSTIC FIBROSIS

Samantha Irving. Royal Brompton and Harefield NHS Foundation Trust

Background: Curvilinearity (Curv) is a novel measure which can be calculated from multiple breath washout (MBW). Lung clearance index (LCI) usually calculated as the mean of 2 or 3 suitable MBWs. It is the most commonly calculated measure from MBW, but is affected by both deadspace effects resulting from lung damage and by specific ventilation inhomogeneity. Curv, however, measures specific ventilation inhomogeneity only, as it describes the shape of the washout curve, which shows poorly ventilated units emptying slowly at the end of the test leading to a long "tail" end to the washout curve.

Previously, Curv has been calculated using a normalised slope analysis of multiple MBW measurements performed by adults and older teenagers, who can perform washouts with a very consistent investigator-imposed tidal volume (V_T). We hypothesised that Curv could also be calculated from means of slopes during normal tidal breathing; and that Curv would be higher in children with cystic fibrosis (CF) than healthy controls.

Methods: 21 children with CF and 32 healthy children (REC reference: 10/H1101/69 NRES Committee South East Coast - Brighton & Sussex) were recruited and performed MBW during normal tidal breathing (Thorax. 2008;63:135-40). LCI was calculated and the mean of 2/3 tests that met quality control criteria as described previously was recorded. From the same MBWs, Curv was calculated as a ratio of the slope from the first half of the test (start to ½ LCI concentration) to the slope of the second half (½ LCI concentration to end) and expressed as a mean.

Results: Results are shown in table 1. Both Curv and LCI ($p<0.001$) are significantly higher in children with CF compared to healthy controls. Results when compared to previous data were comparable except mean Curv, which was lower than previously published (Respir Physiol Neurobiol. 2013;188:124-32).

Conclusion: Curv can be calculated from MBW curves obtained during normal tidal breathing, and results in healthy controls are comparable with those described previously. Curv is raised in CF, along with LCI, demonstrating evidence of specific ventilation inhomogeneity as well as increased deadspace in these children, although Curv is lower in these children than previously published adult results.

	Healthy controls	CF patients	Previously published healthy controls	Previously published CF patients
n	21	27	25	45
Gender (M:F)	6:15	7:20	14:11	28:17
Age	11.5 *(6-17)*	13 (7-16)	*27 (24-30)*	*28 (24-29)*
LCI (mean, *SD, ULN)**	6.79 *(0.48, 7.74)*	9.9 (2.3)	6.2 (0.4, 6.98)	9.4 (2.4)
Curv (mean, *SD, ULN)**	0.16 *(0.08, 0.32)*	0.46 (0.38-0.52)#	0.18 *(0.07, 0.32)*	0.56 (0.48-0.6)#

*Table 1 – LCI and Curv in a cohort of healthy control children, and children with CF. Also shown are previously published data. *ULN only given for health controls. #Median and 95%cl.*

PREDICTING HRMAX IN PATIENTS ON B-BLOCKERS. CHOOSING THE RIGHT EQUATION DURING CARDIOPULMONARY EXERCISE TESTING

Adrian Kendrick. University Hospitals, Bristol

Background: Cardiopulmonary exercise testing (CPET) requires a maximal heart rate to be within 15 bpm of the predicted value to be classified as a maximal exercise test. Usually HR_{max} is predicted from the equation (220 - age). Where a patient is taking b-blockers, HR_{max} is unlikely to be achieved as defined by the standard equation. In some patient groups, where the Chronotropic Reserve Index (CRI) is a useful guide, this will be underestimated and a CRI of < 0.6 may be associated with a potential adverse outcome in patients.

Aim: This retrospective data analysis compared the standard HR_{max} prediction to three equations that predict HR_{max} in patients prescribed b-blockers (Fernandes Silva *et al*, 2012, J Card Fail 18: 831 - 836; Keteyian *et al*, 2012, Med Sci Sports Exerc 2012, 44: 371 – 376; Brawner *et al*, 2004, Am Heart J, 148: 910 – 916).

Methodology: Data on 50 patients undergoing a maximal treadmill test for clinical purposes was reviewed. HR_{max} was estimated from the standard and the three additional equations. For each patient, the CRI was estimated using the equation – $[(HR_{max} – HR_{rest}) \div (HR_{pred} – HR_{rest})]$, where HR_{pred} is from each of the equations. Data was compared between each equation and the recorded HR_{max} for each patient. Data are presented as median (range).

Results: Age - 58.5 (32 – 78) yrs, HR_{rest} – 72 (49 – 78) bpm and HR_{max} - 116 (101 – 133) bpm. Using one-way ANOVA with Dunnett's multiple comparisons test, the standard equation gave significantly lower ($p < 0.001$) values compared to each of the equations (Figure 1). Similarly, for CRI, all values for the standard equation were < 0.60, whilst for the other equations all values were > 0.73 and were significantly higher ($p < 0.001$) than the standard equation (Figure 2).

The slopes of the relationships between the standard equation and the Keteyian, Brawner and Fernades Silva equations for CRI were 1.74, 1.24 and 1.19 respectively. Using linear regression analysis with slope comparison, it was noted that the slope from the Keteyian equation was significantly different ($p < 0.02$) to the other equations.

Conclusion: In patients undergoing CPET who are taking b-blockers, using an HR_{max} prediction equation that reflects the use of this medication provides a more accurate assessment of HR response to exercise, and is essential where accurate determination of the CRI is important for clinical purposes.

Figure 1. %HRmax for each equation (mean ± SD)

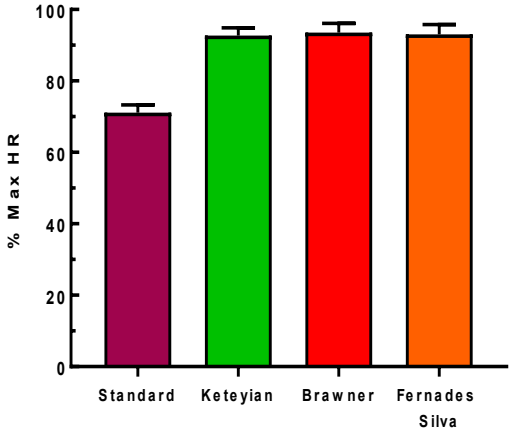
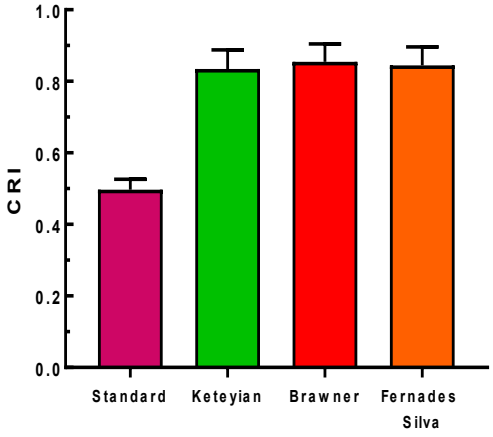


Figure 2. Calculation of CRI for each equation



EVALUATION OF LUNG FUNCTION TESTING IN CHILDREN WITH SICKLE CELL DISEASE

Philip Lawrence. Alder Hey Children's Hospital, Liverpool

Introduction: Studies have found that children with sickle cell disease (SCD) suffer multiple respiratory conditions such as asthma, sleep apnoea and a gradual decline in lung function. These conditions lead to an increased risk of complications such as painful crisis and acute chest syndrome. There are currently no guidelines regarding assessment of lung function in children with SCD.

Aims: This service evaluation aims to investigate whether children with abnormal lung function can be identified through their symptoms alone or whether screening should be introduced. .

Methods: Patients with SCD were recruited and asked to fill out a questionnaire based on respiratory symptoms and perform spirometry. Some also carried out respiratory exercise testing and overnight oximetry. The questionnaire results were scored based on severity and compared with the results of the pulmonary function tests. Man Whitney U tests were used for statistical analysis and $p<0.05$ was considered significant. Ethical approval was not required for this clinical evaluation.

Results: Of the 18 patients recruited (age range 4-18), 0 had evidence of obstructive disease or asthma and 2 had evidence of restrictive disease. Of the 9 that completed overnight oximetry, 5 patients (56%) had abnormal overnight studies with saturations falling below 90%. There was no correlation between questionnaire score and FEV_1% predicted (p-value = 0.61), FVC% predicted (p-value = 0.79) or overnight oximetry results (p-value = 0.61).

Conclusion: This evaluation did not find evidence of significant lung function abnormalities in children with SCD. However, it does demonstrate a high prevalence of sleep apnoea. These patients did not have typical symptoms of sleep apnoea and so cannot be identified through symptoms alone. This indicates overnight oximetry testing should be introduced in children with SCD.

Table 1. Descriptive Statistics

n	18
% Males	55.5%
Age (years)	10 (4-18)
Questionnaire score	6 [3-20]
FEV_1 (% pred)	95 [82-97]
FEV_1/FVC Ratio (%)	85 [81-86]
TLC (% pred)	89 [87-99]
ONSS normal %	44.4%

Median (Range) or [Interquartile Range]

Table 2. Comparison between patients with normal and abnormal overnight saturation studies

	Normal	Abnormal	*p* value
n	4	5	/
% Males	25%	80%	ns
Age	10 (7-16)	9.5 (9-18)	ns
Questionnaire Score	5 [4-38]	8 [3-28]	ns
FEV_1 % Pred	96 [95-100]	91.5 [80-104]	ns
Ratio %	83[82-86]	86[79-87]	ns
TLC % Pred	86[82-95]	89 [88-94]	ns

Median and (Range) or [Interquartile Range]

PREVALENCE OF RESTRICTIVE SPIROMETRY IN PATIENTS WITH ADULT CONGENITAL HEART DISEASE (ACHD).

Edward Parkes. University Hospital Coventry & Warwickshire

Background/Objectives: Surgical repair of congenital heart disease has become common practice and increasingly patients reach adulthood. Surgical techniques including a thoracotomy or sternotomy have been associated with decreased lung compliance, respiratory muscle weakness, impaired breathing mechanics and a restrictive spirometric pattern. Multifactorial dyspnoea is a common symptom in ACHD. The purpose of this study is to define the prevalence of restrictive spirometry (RS) in ACHD and ascertain the impact on exercise capacity.

Methods: Consecutive patients who attended our hospital between 2014 and 2018 for routine cardiopulmonary exercise testing (CPET) including spirometry were reviewed. Clinical data was obtained from the CPET report and the patient's electronic records. Spirometry was assessed for quality according to ARTP/BTS standards. Patients who did not meet these criteria were excluded.

Results: In total 48 patients with ACHD performed spirometry and CPET. Patient demographics are shown in table 1. Most patients, 79%, achieved technically acceptable and reproducible spirometric data reporting normal (31), obstructive (1) and restrictive patterns (6). Thoracotomy/sternotomy was identified as a risk factor for RS (odds ratio=7.14, p=0.042). Overall, 45% of patients demonstrated a reduced peak VO_2 (<81% pred). Patients with RS showed a lower mean peak VO_2 and Eq.CO_2 at anaerobic threshold (AT) (79% vs 89%; 35 vs 31, respectively) (Figure 1). RS is a risk factor for a reduced exercise capacity (odds ratio=8.333, p=0.066).

Conclusions: There is a low prevalence of RS in our small single centre patient cohort of ACHD. Previous thoracotomy or sternotomy are possible risk factors for RS. Patients with RS have a lower peak VO_2 and Eq.CO_2 which may contribute towards patient's symptoms. Further, larger studies are required to investigate alternations in breathing mechanics and specific drivers for SOB in patients with ACHD.

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N=38	Mean (SD)
Sex (m) (%)	40
Age (years)	34 (15)
BMI	24.9 (4.6)
Smoking (pack/years)	0.5 (0.9)
Beta Blockers (%)	15
Surgery (%)	68
Thoracotomy/ Sternotomy (%)	29
FEV1 (%pred)	91 (17)
FVC (SR)	-0.5 (1.3)
Peak VO2 (%pred)	87 (21)
Eq.CO2 AT (units)	32 (4)
O2/HR (ml/beat)	12.7 (4.1)
Max HR (%pred)	81 (12)

Table 1. Patient demographics.

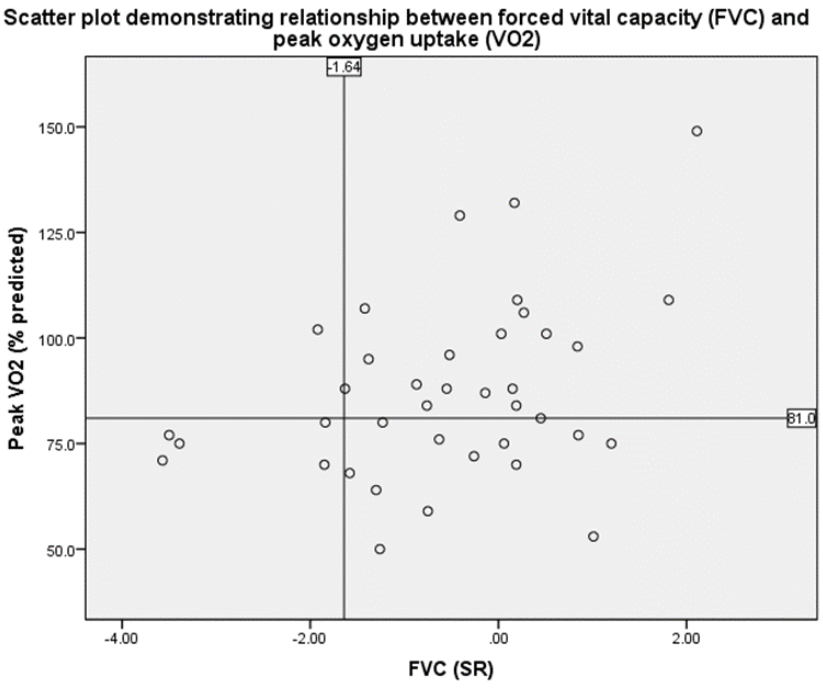

Figure 1. Relationship between forced vital capacity (FVC) (SR) and peak oxygen uptake (VO2) (%predicted). Vertical line represents -1.64 SR. Horizontal line represents 81% predicted peak VO2

THE UTILITY OF NIV IN MND PATIENTS WITH BULBAR SYMPTOMS

Holly Van Ristell. University Hospital Coventry & Warwickshire

Background: The loss of motor neurones is the hallmark of motor neurone disease. This can present as limb, respiratory or bulbar muscle weakness or a combination of all. Bulbar weakness can be true (upper motor neurone loss) or pseudobulbar weakness (lower motor neurone loss). Bulbar weakness can be the initial presenting symptom or develop as the disease progresses. The literature has suggested that patients with bulbar onset symptoms are six times less likely to tolerant NIV (Gruis, 2005). It has also been proposed in the literature that higher pressures can lead to intolerance of positive pressure (Andersen, 2016). The NICE guidelines (2016) on the assessment and management of motor neurone of motor neurone disease recommend that all motor neurone disease patients are given the option to trial NIV when respiratory function results suggest the need for it.

Method: All patients who had a previous diagnosis of MND and referred to the respiratory physiology and sleep department for commencement of NIV according to NICE guidelines were reviewed. Patients were sub grouped into bulbar and limb onset MND. We compared compliance, starting pressures, pre-NIV SNIP, set up arterial blood gas and time from diagnosis to NIV initiation. Patient demographics were collected from the departments NIV database.

Results: The results found no significant difference in compliance at 90 days (11 patients in the bulbar patient group compared to 8 in limb group) (p= 0.734) between bulbar and limb onset patients. There was also no significant difference in survival time (280 days compared to 294 days) (p=0.897). No significant difference was found in pre NIV PCO_2 (p=0.662). There was no significant difference in starting IPAP (mean of 13cmH_2O compared to 15cmH_2O) (p=0.86) or starting EPAP (mean of 5 cmH_2O compared to 5cmH_2O) (p=0.142). There was a borderline difference (p=0.45) in the time from diagnoses to starting NIV with a mean time from diagnoses in bulbar patients being 212 days compared to 405 days in those with limb onset. Incidentally we discovered that only two patients within this cohort used a nasal mask, all other patients used a full-face mask.

Conclusions: Our data has found that there was no significant difference with compliance at 90 days between limb onset and bulbar onset patients. We also found that starting pressures were similar as was starting PCO_2. This therefore suggests that bulbar patients can be successfully initiated onto NIV and remain as compliant as limb onset patients at 90 days. This data appears to show that there may be a need to start NIV in bulbar patients at an earlier point within disease progression. However, more research into this will need to be conducted to prove this theory. This data does suggest that we need to consider a less nihilistic approach to the use of NIV in bulbar MND patients.

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DETERMINING THERAPEUTIC CONTINUOUS POSITIVE AIRWAY PRESSURE USING AUTO CPAP DEVICES OR ESTIMATES BASED UPON SEVERITY

Richard Glover. Good Hope Hospital, Sutton Coldfield

Introduction: The local service has recently changed from using Autoset devices to titrate CPAP pressure prescription to setting pressure using disease severity and subsequent objective measurement.

Aim: The aim of this service review was to assess clinical outcomes when comparing the two methodologies Autoset titration vs. Fixed pressure titration.

Methods: 6 months of data was obtained for subjects attending for titration studies (first 3 months) and disease severity (subsequent 3 months). CPAP usage, Epworth score and 4% ODI was measured on the prescribed pressure after one month of CPAP therapy.

Results:

	Autoset titration n=75	**Fixed Pressure titration** n=82	**P value**
AHI	24.5 [6.3- 78.0]	26.4 [5.2 -121.3]	0.240
ODI (%)	2.4 [0.4-12.0]	2.3 [0.0-22.3]	0.702
Pressure (cmH2O)	11.0 [6.0-16.0]	12.0 [10.0-17.0]	0.004*
CPAP usage (hours)	6.1 [1.6-8.8]	5.3 [0.0-11.0]	0.020*
Pre-treatment ESS	11.6 (4.9)	12.0 (5.1)	0.467
Post treatment ESS	5.0 [0.0-21.0]	5.0 [0.0-21.0]	0.706
ESS Improvement	5.0 [-1.0-14.0]	5.0 [-1.0-19.0]	0.682
Consented to long term CPAP	43 (57.3)	59 (72.0)	0.055
Compliant with CPAP	34 (82.9)	40 (69.0)	0.115

Table. 1. ESS = Epworth sleepiness score. Compliant with CPAP = ≥4 hours average nightly usage.

Discussion: There were a similar number of subjects who consented to long term CPAP therapy following each titration study. The proportion of subjects compliant with CPAP, the 4% ODI and improvement in ESS was similar irrespective of methodology. Conclusion: Lower pressure requirement and higher CPAP usage was found in subjects who had undergone an Autoset titration study; the significance of this is unclear as there were a similar proportion of subjects compliant with CPAP in each group. Local services should consider using predictive equations which are evidenced based and may result in lower pressure when basing estimates upon disease severity.

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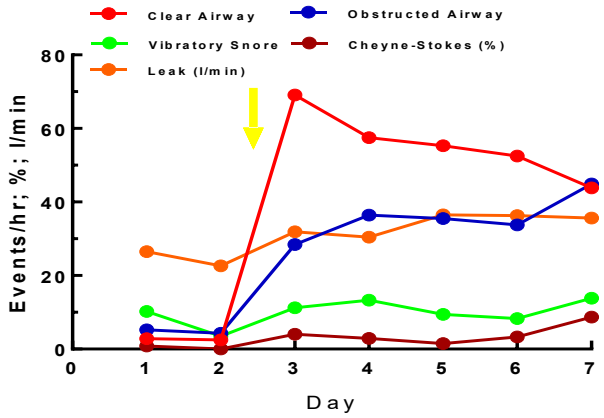
CLOSE ENCOUNTER OF THE MORPHINE KIND? WHEN TELEMEDICINE WOULD HAVE BEEN REALLY USEFUL - A CASE REPORT

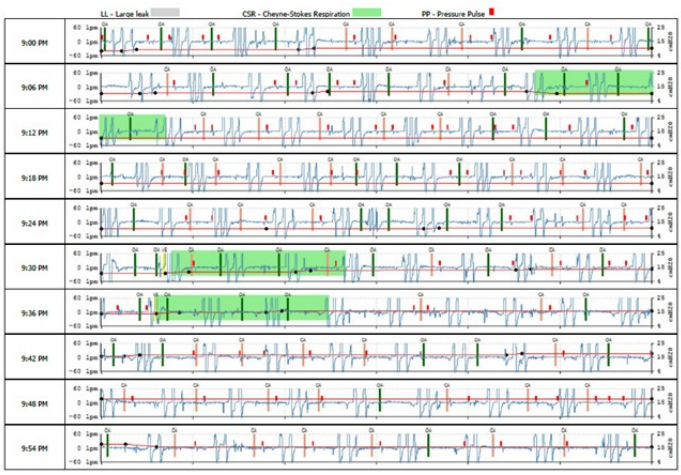
Adrian Kendrick. University Hospitals, Bristol

Background: A 65 year old male was referred for a trial of auto-CPAP after overnight oximetry showed a 4% ODI of 30.00/hr, a 3% ODI of 39.8/hr, a D12 index of 1.39 (ULN = 0.60) and spending 3.8% of the night at < 90% SpO2. He had an Epworth score of 3 and a BMI of 45.8 kg.m-2. In addition he had T2 diabetes and hypertension. He is a driver, not sleepy when driving, does not consume caffeine or alcohol.

On review after 100 days usage, the CPAP download showed excellent adherence of 98%, with an average usage of 9.4 hrs/24 hrs. Sleep was disturbed throughout the night due to back pain and he took a designated nap most afternoons for about 1 – 2 hours. His partner noted that the CPAP device was not working so well recently. The individual data download over the previous 7 nights showed some interesting changes -



There was a sudden and significant increase in Clear (Central) and obstructed airway measures between days 2 and 3, tying in with the observation of the partner. The patterns were confirmed by the breath-by-breath data –



On questioning, the patient's increasing back pain resulted in being prescribed high dose Morphine, which although alleviating some of the pain, still needed higher dosage. He had taken morphine between day 2 and day 3. The patient was immediately transferred on non-invasive ventilation to manage his changed breathing patterns.

Learning points: This case illustrates that –

1. The sudden and dramatic effects of morphine type drugs on breathing patterns picked up by the auto-CPAP data download.
2. Listening to the patient and partner indicated that auto-CPAP was not working as well as it had previously
3. The importance of good communication between different healthcare practitioners prior to significant changes in medication known to have potentially adverse effects on breathing patterns
4. Had we not seen this patient when we did and as planned, the outcome may have been adverse
5. Had we been using telemedicine, this dramatic change in breathing events would have been picked up much sooner and been monitored much more closely.

IS 4 HOURS ENOUGH? COMPARING RECORDED SLEEP PARAMETERS FROM THE FIRST 4 HOURS OF SLEEP WITH THE TOTAL SLEEP STUDY RESULTS.

Aidan Laverty. Great Ormond Street Hospital for Children NHS Foundation Trust. London

Introduction: The current AASM scoring manual for PSG studies in children does not specify quality standards or methods of quality control. The only national document (Royal College of Paediatrics and Child, 2009), published in 2009, identified this as an area of concern, recommending recording a minimum of 6hrs of sleep as being desirable. We wanted to determine if the first 4 hours of sleep was representative of the full night of sleep in respect to particular sleep parameters in paediatric patients with neuromuscular conditions.

Methods: A retrospective study of all studies on patients with neuromuscular conditions since January 2017 to present who showed moderate or severe obstructive sleep apnoea and/or hypoventilation. The first 4 hours of sleep were calculated from sleep onset and selected sleep parameters from this period compared with the parameters from the total study.

Results: 30 patients were reanalysed (13 moderate, 10 severe, 7 hypoventilation). A Wilcoxon signed-rank test was used on: Mean SpO_2, Mean nadir SpO_2, ODI, AHI, Mean Transcutaneous CO_2 ($TcCO_2$), Maximum $TcCO_2$. The Wilcoxon test indicated that maximum $TcCO_2$ was higher when taken from the total study than during the first 4 hours of sleep. It further showed the mean $TcCO_2$ as higher during the first 4 hours of the recording however this just reached statistical significance.

Conclusions: Maximum $TcCO_2$ when taken from only the first 4 hours of sleep does not accurately reflect the level achieved in this patient group when the entire study is analysed. There was mild disparity between analysis periods for mean $TcCO_2$. Other parameters were not different. In this small cohort of neuromuscular patients, 4 hours of recorded sleep may be able to detect sleep disordered breathing when hypoventilation is not present. Further work is needed on other disease groups and Total Sleep Time (TST) where $TcCO_2$>6.7kPa will be calculated.

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	First 4hrs *Median (IQR)*	Total sleep recording *Median (IQR)*	*Z*	*Sig (2-tailed)*
Mean SpO_2 (%)	95.9 (94.9-96.9)	96.3 (95.2-97.0)	-1.237	0.216
Mean SpO_2 nadir (%)	92.1 (91.5-93.4)	92.1 (91.2-93.3)	-0.521	0.603
Oxygen desaturation index (≥3%) (dips/hr)	12.5 (5.6-17.8)	13.6 (9.6-18.0)	-0.854	0.393
Mean $TcCO_2$ (kPa)	**6.0 (42.5-49.8)**	**5.9 (42.1-48.1)**	**-1.971**	**0.049**
Maximum $TcCO_2$ (kPa)	**6.5 (45.5-53.4)**	**6.8 (47.6-54.0)**	**-3.724**	**<0.001**
Total apnoea/hypopnoea index (AHI)	6.6 (3.0-11.7)	7.5 (4.9-13.7)	-0.772	0.440

ARE SUBJECTIVE OUTCOMES INFLUENCED BY THE USE OF HUMIDIFICATION?

Sara Parsons. St George's Hospital NHS Foundation Trust

Background: Continuous positive airway pressure is the gold standard treatment for obstructive sleep apnoea (OSA). There is varying practice across the UK regarding the implementation of humidification and the impact this adjunct therapy has on subjective measures.

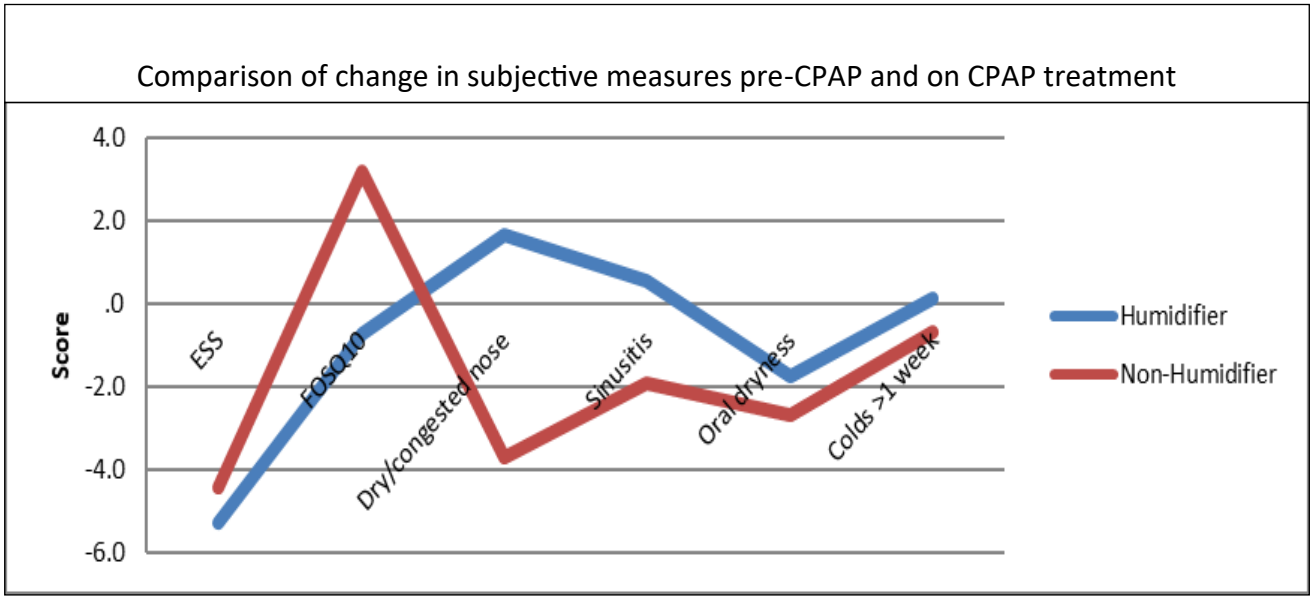
Aim: To compare sleepiness, fatigue and quality of life in patients using CPAP with and without humidification.

Methods: 20 patients newly diagnosed with moderate-severe OSA was randomly assigned to either CPAP without humidification (WOH) or CPAP with humidification (WH). Patients were set up using the F&P ICON AUTO CPAP device (4.5 – 20 cmH_2O). Patients were shown and encouraged to change the humidification level based on comfort. The pathway for CPAP therapy was as per local protocol. Questionnaires including the Epworth sleepiness scale (ESS), functional outcomes of sleep (FOSQ – 10) and visual analogue score for nasal symptoms were performed prior to therapy initiation and on reaching CPAP compliance. Research was sponsored by F&P Healthcare. Ethics approval was obtained by London – South East Research Ethics Committee (Ref – 15/LO/0049).

Results: 4F:8M (mean ± SD - age 50 ± 10 yrs, AHI 45.3 ± 28.4 hr) in WOH group and 4F:4m (mean ± SD - age 47 ± 10 yrs, AHI 47.2 ± 26.2 hr) in WH group. There was no significant difference in the subjective measures as reported by the ESS (p=0.770) and FOSQ-10 (p=0.486) demonstrated by Mann Whitney-U statistical test. The WOH group experienced more dryness and nasal congestion prior to starting treatment (p=0.018) when compared to the WH group although no significant difference once on therapy (p=0.767). There was a significant difference (Mann Whitney-U statistical test) in the change of dryness and nasal congestion with the WOH experiencing the greatest reduction in dryness and nasal congestion (p=0.012).

Conclusion: We found no significant difference in the ESS and FOSQ-10 between the WOH and WH groups. Surprisingly, the WOH group were more dry and congested and they also reported the biggest improvement, questioning the need for humidification at the start of CPAP therapy. However, this needs further investigation with a larger sample size and across seasons.

Comparison of change in subjective measures pre-CPAP and on CPAP treatment



SCREENING AND DIAGNOSIS OF OBSTRUCTIVE SLEEP APNOEA IN PREGNANCY

James Pearson. Swansea University & Great Ormond Street Hospital for Children, London

Introduction: Sleep disordered breathing in pregnancy (SDBP) is associated with adverse maternal and foetal outcomes[1]. SDBP is probably underdiagnosed because presentation is atypical, symptoms may be hard to discriminate from those experienced in 'normal' pregnancy and the severity is typically mild compared to the general population[2]. Clarity is needed on the most appropriate way to identify SDBP.

Aims: This literature review focused on:

1. To investigate what i) screening and ii) diagnostic methods are currently being used to detect SDBP.
2. To investigate strengths and limitations associated with current screening and diagnostic modalities for SDBP.
3. To identify gaps in research in relation to screening and diagnosis of OSA in pregnancy.

Method: A systematic search was carried out using four databases: Scopus, Medline, Web of science and PubMed. Search terms included:

(Apnea or Apnoea or Sleep Apnea or Sleep Apnoea or Obstructive Sleep Apnea or Obstructive Sleep Apnoea or Obstructive Sleep Apnea Syndrome or Obstructive Sleep Apnoea Syndrome or Obstructive Sleep Apnea Hypopnea Syndrome or Obstructive Sleep Apnoea Hypopnoea Syndrome or OSA or OSAS or OSAHS) AND (Pregnant or Pregnancy) AND (Incidence or Prevalence or Occurrence) AND (Diagnosis or Screening or Presentation).

Inclusion and exclusion criteria:

1. Studies looking at either obstructive sleep apnoea (OSA) or sleep disordered breathing (SDB) in the pregnant population.
2. Studies published in the last five years were included.
3. Duplications were removed.

Results: 29 papers were included in the analysis, this included 5 literature reviews, 19 cohort studies, 3 cross sectional studies, 1 meta-analysis and 1 comparative study. The most common method used to screen for SDBP in the literature was the Berlin Questionnaire.

Discussion: Many studies have demonstrated an association between questionnaire scores and adverse outcomes although questionnaires used do not reliably predict an objective diagnosis of OSA, and often have poor specificity[3–5]. PSG is the gold standard approach used to diagnose SDBP but is resource-intensive and may not be acceptable to pregnant women[6]. Limited channel monitors cannot identify respiratory effort-related arousal and because SDBP tends to exist at the mild end of the spectrum, these monitors may lack sensitivity[4]. Relatively new devices, such as WatchPAT have been validated but tend to overestimate severity compared to PSG[7].

Conclusions: Limited channel studies and screening questionnaires may lack concordance with PSG but they still have utility in terms of predicting perinatal risk[1]. Further research is required to assess the most appropriate timing and threshold for intervention in SDBP. The benefit of intervention such as CPAP remains unclear[8,9].

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AN EVALUATION OF SPIROMETRY TRAINING.

Charlie Earle. Swansea University

Methods: Between 2016-2018, interactive 2-day training was delivered across 2 health boards in South Wales (ABMU and HDU). A various locations were used to maximise staff access:

- Day 1 – Practical quality-assured diagnostic spirometry
- Day 2 – Interpretation of real-life results

123 candidates successfully completed a standardised spirometry assessment at the beginning of Day 1 (pre) and at the end of Day 2 (post).

Learner feedback at the end of each training day was sought with eight standardised questions addressing content and delivery. The questionnaire used in this training was written by ARTP. Participants completed standardised ARTP assessments according to the level of accreditation selected. These were conducted by ARTP-accredited University staff. Candidates completed a comprehensive portfolio with a practical assessment (OSCE) if completing foundation or full certificate levels.

Results: Candidates who did not complete both assessments were excluded from this analysis (n= 76). Reasons for non-completion include; candidate withdrawal, selection of a one day course (levels 1 or 2) and non-attendance. All other candidates enrolled up to October 2018 were included (n= 123).

A paired t-test of Pre- and Post-course assessment scores showed a significant ($t(122) = -20.740$, $p<0.001$) change in assessment scores. The mean assessment score improvement was 30.89% (see Table 1).

Course feedback from 142 candidates indicated learner satisfaction, with 96% of answers in the agree or strongly agree categories. For transparency, this data includes 14 incomplete questionnaires and 3 questionnaires with possible misunderstanding, i.e. poor scoring but excellent written feedback, so it is likely that satisfaction is in fact higher than 96%.

	Pre-course	Post-course	Pre-Post difference
Mean (%)	44.03	74.93	30.89
St.Dev	17.31	10.89	16.52
		P-value	<0.001

Table 1) Showing mean and standard deviation for pre and post-course assessment scores (n=123)

A total of 199 candidates signed up for spirometry training with Swansea University, across all three levels of certification (interpretation certificate n=3, foundation certificate n=24, full certificate n=172). Two (1%) candidates (both Nurses) completed the course twice due to medical reasons; from here on, their data has been counted only once.

A total of 190 candidates completed the appropriate number of study days for their level (95%). Out of these, 43 (23%) candidates withdrew from the course, 44 (23%) failed to submit work within the deadlines, 2 candidates completed the portfolio but not the OSCE (1%) and 101 (53%) candidates completed the course (passing both portfolio and OSCE).

Conclusion:

- The training model employed by the University was effective at reducing the knowledge gap across the Health Boards
- Candidate satisfaction regarding training was exceptionally high
- Over half (53%) of the candidates who enrolled on the course completed (passing both portfolio and OSCE)
- The number of candidates who failed to submit work was a limiting factor to the success of the course. Basic feedback from candidates in this category related to the magnitude of work surrounding the portfolio, with inadequate time allocation (in work).
- Long-term audit of clinical practice is still required to ensure that the training translates to clinical practice

A COMPARATIVE STUDY OF COUGH PEAK EXPIRATORY FLOW (CPEF) USING FULL FACE MASK VS MOUTHPIECE INTERFACES IN HEALTHY SUBJECTS

Aaron James. Plymouth University Hospitals NHS Trust

Background: Cough Peak Expiratory Flow (CPEF) is a respiratory muscle function test designed to assess the ability to clear airway secretions adequately. Present practice requires CPEF to be measured using a mouthpiece, which has proven problematic in patients the neuromuscular disease (s). The study aimed to determine the effectiveness of using a facemask vs mouthpiece in measuring CPEF.

Hypothesis: CPEF measured via an Interurgical Anaesthetic Full-Face Mask will provide comparably similar (CI 0.95) Results to those obtained using a flanged mouthpiece.

Participant Population: Healthy participants were recruited into the study through faculty newsletters, social media advertisements and random convenient sampling of network connexions. Participants were screened, following ethical approval, using a specifically-designed Pre-screening Medical Questionnaire (PSMQ) against an Inclusion criterion, before inclusion to the study.

Methods: Testing procedure ensured standard spirometry position was adopted. The participant was asked to expire to residual volume (RV), followed by a rapid inhalation to total lung capacity (TLC) where a forceful cough manoeuvre was made. Procedure was repeated at least 3 times, with 45 s rest between attempts. A maximum of 8 attempts per interface was allowed, with a 10 min change-over period between interfaces. A students 2-sample t-test , Bland-Altman and regression analysis were employed to statistically analyse the data. Randomisation occurred using the excel RAND command on the sample ID's.

Results: 60 healthy subjects were recruited, of which 58 participant's Results were deemed appropriate to study. The mean result of each interface was analysed to indicate no significant differences of CPEF measurements in healthy subjects (CI 95%, p=0.971). There were no significant differences between Age and Gender (CI 95%, Age p=0.453, Gender p=0.902) with the different interfaces. Analysis of each interfaces' maximal effort (CPEFmax) indicated no significant differences (CI 95%, p=0.943). Randomised sequence data was analysed, where it concluded that there was no significant influence of interface sequencing on the results (CI=95%, p=0.671).

Conclusion: The study's Results support the hypothesis, suggesting interchangeability of both interfaces. This now offers a platform for further study in the viability of facemask CPEF within the clinical setting, as well as providing a standardised protocol and CPEF reference values.

HYPOXAEMIA FROM USING AN ADULT OXYGEN FACE MASK IN A PAEDIATRIC PATIENT

Kylie Russo. Great Ormond Street Hospital for Children NHS Trust. London

Introduction: A 2-year old boy with cleft lip and palate presented for an overnight sleep study. The prescribed study plan was to begin the study in air then switch to the patient's standard home regime (1L/min of supplemental oxygen via face mask) once specific SpO_2 criteria were reached. The patient's mother provided the face mask issued by the Community team and used at home which was applied from 01:30am (the vertical blue line in Figure 1) following multiple desaturations. The mask was in place with 1L/min O_2 for 15 minutes, without noticeable change in SpO_2 from the situation while in air.

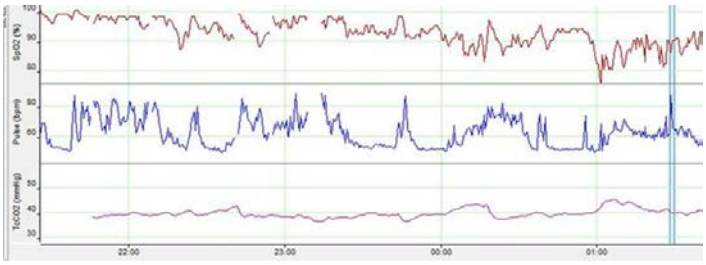

Figure 1 SpO_2, Pulse rate and $TcCO_2$ in air with home mask applied at position of blue line

The 'home' mask was changed to a standard hospital ward oxygen mask (Intersurgical EcoLite) and supplemental oxygen continued at 1 L/min, as before. There was an immediate and sustained improvement in baseline SpO_2, which stabilised at a normal level (the red line in Figure 2).

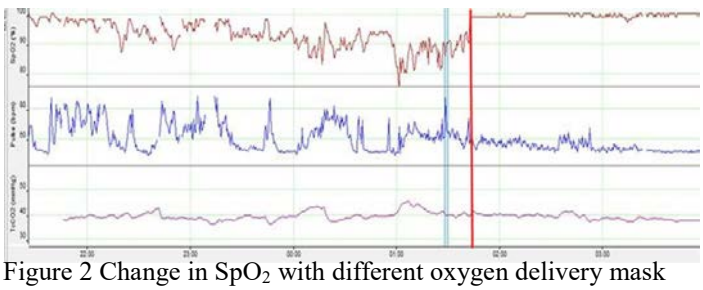

Figure 2 Change in SpO_2 with different oxygen delivery mask

On investigation, it transpired that the 'home' mask issued by the Community team was a Venturi mask requiring 4L/min to deliver 28% oxygen.

Conclusion: This study highlights the potential for error when using a patient's own supplemental oxygen delivery mask rather than the hospital standard (and familiar) mask. The event was used as a teaching/training example and disseminated to the sleep physiologist team.

EARLIER USE OF FRACTIONAL EXHALED NITRIC OXIDE (FENO) AND CHALLENGE TESTING IMPROVES SPEED AND ACCURACY OF ASTHMA DIAGNOSIS.

Jill Macleod. NHS Lothian

Introduction: There is considerable concern regarding over and under diagnosis of asthma. The majority of patients with asthma present with normal lung function which can contribute to misdiagnosis and many practices in primary care have limited facilities for testing patients. Although national asthma guidelines advocate additional tests such as FeNO and challenge testing to support a diagnosis, these investigations are often not available in primary care. We hypothesised that our new protocol that places FeNO and challenge testing earlier in the pathway would promote faster, more accurate diagnosis. This in turn should result in more appropriate and timely treatment for the patient and reduced referrals to secondary care Respiratory Medicine clinics.

Method: All referrals from primary care to Respiratory Physiology for patients with a possible diagnosis of asthma and normal Spirometry had further tests authorised by a Respiratory consultant. Appointments were given for two additional tests; FeNO, a surrogate marker of eosinophilic inflammation and a bronchial challenge test (Osmohale Mannitol challenge or Exercise Induced Asthma test for patients under 18 years). The results were reported directly to the GP with advice on further action to be taken. The time in days from initial referral from primary care to the day the results were available for the GP was measured. A questionnaire was distributed to the GPs for feedback on the further investigations.

Results: Over a six month period, 86 patients were offered the additional tests and of these, 76 patients attended with 10 declining or failing to attend Of the patients tested, 29 patients had a raised FeNO, 21 patients had a positive challenge test and 13 patients had both. The median time taken from referral to result was 57.5 days (range 34 - 118 days), with the longer waits generally due to cancellations and reappointments. The feedback from the GPs (n=64) was positive with 100% of those responding finding the additional investigations useful and 79.7% reporting it had saved a referral to Respiratory Medicine.

Conclusion: The new protocol has considerably reduced the patient pathway for a new diagnosis of asthma, resulting in patients having their diagnosis confirmed much earlier. Reporting results directly to primary care has resulted in a decrease in referrals to Respiratory Medicine. This could create additional clinic capacity and help reduce waiting times.

A SERVICE AUDIT ON THE UTILISATION OF PULMONARY FUNCTION EQUIPMENT WITHIN THE RESPIRATORY PHYSIOLOGY LABORATORY

Liz Walton. Royal Stoke University Hospital

Introduction: Due to the financial constraints the NHS faces and the capacity issues associated with the respiratory departments current infrastructure, the service needs to be remodelled. The department must become more efficient, so that it can be delivered on the same budget and with the same complement of staff/ technology.

Method: To determine baseline variation in the respiratory services daily PFT performance, statistical process control analysis was performed on retrospective data that was extracted from the patient database. Service performance data was collated between January and December 2017. The timeframe of the study was selected to demonstrate service performance over a 12-month period, eliminating seasonal variability. The daily variation recorded in the number of PFT's performed in 2017 was analysed, using Minitab capability analysis software. The process capability index (Cp and Cpk) was used as a statistical measure of service performance and variation. An arbitrary value of 1.33 was assigned to the Cpk based on previous business models related to service improvement. Values greater than 1.33 indicated a robust service. Run charts were assembled to highlight process variation. Data was also mined from 100 randomly selected patients that attended the respiratory physiology department in 2017. Variables selected for audit analysis included: total time spent testing the patient and whether the patient was seen within an appropriate timeframe of their appointment. Further analysis was performed to identify the causes for delays in initiating patient investigations.

Results: The overall process capability of the respiratory service to deliver pulmonary function investigations between January and December 2017 was found to be below the specification limits set (Cpk <1.33). Run chart analysis demonstrated oscillation of the data points ($p < 0.05$), indicating that there was significant fluctuation in the number of PFTs performed daily. The average time respiratory physiologists spent performing pulmonary function investigations on patients was 34 minutes. 44% of patients were seen either on time, or prior to their assigned clinic slot and 56% of patients suffered a delay. The average delay time was 11 minutes. The 6 factors found to contribute to delays in initiation of patient testing were: physiologist 'other', the patient arriving on time to the hospital, but not factoring in the extra time required to navigate the hospitals vast infrastructure and the bottleneck in flow created by the capacity/ demand mismatch at the height and weight room.

Conclusion: The results of the process capability analysis demonstrate that the respiratory service suffers significant fluctuations in the number of PFTs performed daily. This variation reduces the departments effectiveness and negatively impacts on the services ability to create a surge capacity. In conjunction, the results of the patient audit demonstrate that the departments current layout contributes to service inefficiency. Following on from this audit, clinic slots will be reallocated to reduce daily variation and the time allotted to performing pulmonary function investigations will be reduced from 1 hour to 45 minutes. This will allow for the creation of new investigation slots. Height stadiometers and weight scales will also be provided in each laboratory to reduce patient delays.

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PULMONARY FUNCTION AND HEALTH STATUS SCORE IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD). A PILOT STUDY

Lewis Gidden. Cardiopulmonary Department, Worcestershire Royal Hospital, UK

Background: Forced expiratory volume in 1 second (FEV_1) is the most widely used measure of pulmonary function to assess severity of expiratory airflow limitation in COPD. Dyspnoea and exercise capacity are important factors in health status in COPD patients. However FEV_1 correlates only weakly with both and not surprisingly studies have shown that this is also the case with health status[1-2]. Lung hyperinflation has been implicated in the causation of dyspnoea and reduced exercise tolerance and correlates well with both[3], while gas transfer appears to be the best at predicting exercise capacity in COPD[4]. This pilot study aimed to evaluate the correlation between additional measurements of pulmonary function and health status in COPD patients.

Methods: Full pulmonary function testing included oxygen saturation (S_pO_2), spirometry, lung volumes by body plethysmography and single breath transfer factor (T_LCO). Health status was assessed using the COPD Assessment Test (CAT) and the Clinical COPD Questionnaire (CCQ). Pearson's correlation was used to evaluate the relationship between health status score and lung function indices. A p value <0.05 was considered statistically significant.

	CAT Score	CCQ Score
S_pO_2	0.232	0.097
FEV1 %Predicted	-0.048	-0.244
FVC %Predicted	-0.064	-0.062
TLC %Predicted	-0.142	-0.081
RV %Predicted	0.001	0.078
FRC %Predicted	-0.210	-0.132
IC/TLC	0.273	0.085
TLCO %Predicted	-0.204	-0.370

Table 1: Pearson's correlations between pulmonary function measurements and health status score

Results: 16 COPD outpatients patients (6 male), with moderate to very severe COPD were recruited. All patients exhibited gas trapping and lung hyperinflation. No significant correlations were found between pulmonary function measurements and health status score (Table 1). The T_LCO showed a weak negative correlation with CCQ score. This was the best reported correlation but still insignificant (Figure 1).

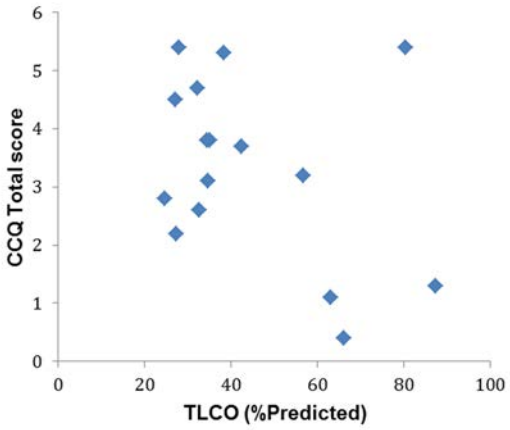

Figure 1: Correlation between TLCO %Predicted and CCQ Total score in COPD patients (r = -0.37, p = 0.158).

Discussion: T_LCO is an important measure of pulmonary function and good predictor of exercise capacity and mortality in COPD. The strength of the T_LCO may lie in its ability to also capture subclinical cardiac co-morbidities[4]. One previous study reported a significant weak correlation between IC/TLC but only in men[5]. The small sample population who were a relatively homogenous group of the emphysematous phenotype makes it difficult to extrapolate results to the wider COPD population. Age, gender, smoking status, weight, co-morbidities are other factors that also influence health status[2]. However this study have neither investigated or taken these into account.

Conclusion: Given the small homogeneous population that this study was performed in it is difficult to draw any definitive conclusions regarding pulmonary function and health status.

This results reported here are in line with previous studies that pulmonary function is not well correlated with health status in COPD.

Therefore both pulmonary function and health status should be measured in COPD.

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CAN PEAK CIRCULATORY POWER BE PROGNOSTICALLY USEFUL IN PATIENTS UNDERGOING ABDOMINAL AORTIC ANEURYSM REPAIR SURGERY? A PILOT STUDY

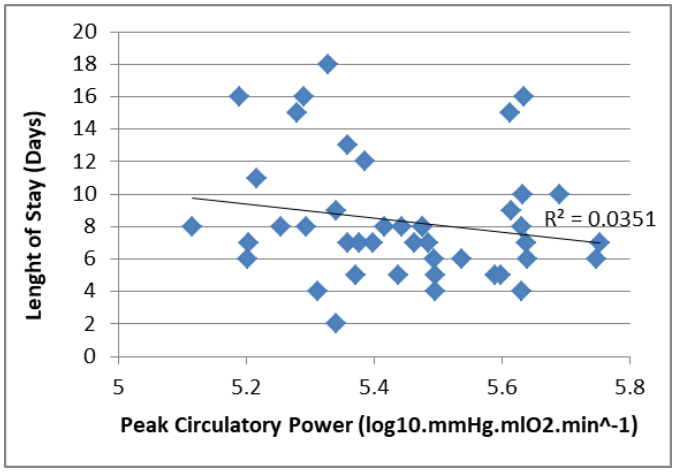
Brett Gregory. University Hospitals Coventry & Warwickshire

Introduction: Cardiopulmonary exercise testing (CPET) is an established preoperative tool that can successfully risk-stratify patients prior to major abdominal surgery (Goodyear, 2013). Anaerobic threshold (AT) and peak oxygen consumption (VO_2) have been the most investigated and subsequently clinically utilised parameters but it remains to be seen if other maximal CPET outcome measures could be of use.

Tang *et al* (2018) demonstrated the use of peak circulatory power (peak CircP) as a parameter of greater predictive value than other exercise measures from a CPET in Idiopathic Pulmonary Artery Hypertension (IPAH) patients. It has also been shown to be of strong prognostic value for chronic heart failure patients (Cohan-Solal *et al* 2002). This pilot study aims to investigate if peak CircP could be of use as a predictor of mortality and postoperative length of stay in open abdominal aortic aneurysm (AAA) surgery.

Methods: A retrospective study was undertaken in which the CPET and postsurgical outcomes of anonymised patients who underwent open AAA repair surgery was analysed between September 2014 and October 2017. 44 patients were found to have completed a CPET as part of preoperative assessment for open AAA repair surgery. Peak CircP was calculated as a product of peak oxygen consumption and peak systolic blood pressure during CPET. Peak CircP, AT and peak VO_2 were compared with 30-day mortality and postoperative length of stay (LOS).

Results: All patients had a mortality greater than 30 days so no analysis of this data could be undertaken. The base 10 logarithm of peak CircP was used as a standard form transformation. No significant association was found between peak CircP ($p=0.68$), AT ($p=0.22$) or peak VO_2 ($p=0.12$) with postoperative LOS.



Discussion: Although the sample size of this study is small, this initial investigation corresponds with other studies that have shown that AT and VO_2 cannot predict the postoperative length of stay following major surgery. Further statistical analysis could yield evidence of a non-linear relationship with some values of peak CircP having greater predictive value than others and the inclusion of data from the endovascular aneurysm repair (EVAR) method and greater patient numbers in the study will increase the weighting to the outcomes.

DYSFUNCTIONAL BREATHING: MAKING A DIAGNOSIS AND EFFECTIVE SYMPTOM MANAGEMENT IN A DISTRICT GENERAL HOSPITAL.

Scott Hawkes. Liverpool Heart And Chest Hospital

Introduction: By definition dysfunctional breathing (DB) exists whereby individuals display sustained chronic changes in breathing patterns which results in dyspnoea in the absence of organic cardio-respiratory pathology. It is thought that as many as 6-10% of the population develop abnormal breathing patterns and as many as 29% in the asthmatic population. In this trust patients can be referred to an outpatient physiotherapy clinic to help limit symptoms. The investigations required to establish a diagnosis can be extensive due to the differential diagnoses of chronic dyspnoea and the lack of a definitive diagnostic test.

Aim: To quantify the investigations requested by chest physicians to make a diagnosis of DB, whilst assessing the outcomes from front-line thoracic physiotherapy.

Methods: We retrospectively analysed referrals from 44 patients diagnosed with DB and referred to thoracic physiotherapy. Route to referral was assessed including investigations undertaken and previous cardiology referrals for dyspnoea. Thoracic physiotherapy outcomes were assessed with pre v.s post Nijmegen questionnaire.

Clinical Investigations Performed	n/44	%
Spirometry	42	91
Gas Transfer (Tlco)	26	59
FeNO (Fractional exhaled nitric oxide)	23	52
Bronchial Challenge Testing (Mannitol)	4	10
CXR	43	98
CT Chest	25	57

Table 1. Clinical investigations performed before a diagnosis of DB and subsequent referral

Results: Of the 44 patients referred 73% (32) were females, with a mean age of 55±17. Nijmegen was 28±10 and reduced to 21±10 (p=0.003) following treatment, within an average 2.5±0.8 appointments. 45% (20) had previously been investigated for dyspnoea by a cardiology unit. Over 90% of patients performed spirometry and a CXR, over 50% performed more detailed clinical imaging and physiological testing (table 1).

Conclusions: It is clear that thoracic physiotherapy including breathing retraining is a cheap and effective tool in helping symptom management, and despite its clear clinical limitations the Nijmegen questionnaire remains a practical tool in assessing physiotherapy outcomes. The lack of a definitive diagnosis for DB means that most patients perform extensive cardio-respiratory investigations prior to a diagnosis. The substrate for dyspnoea means that patients are often seen by dual specialties delaying the time to diagnosis at cost to both NHS and patient. Going forward it is evident that streamlining symptom led investigations may help put patients onto a treatment pathway sooner, despite no definitive diagnostic test, investigations that stress both respiratory and cardiovascular systems concurrently such as CPET may help drive service development.

AN EVALUATION OF REFERRAL SOURCES AND PATIENT OUTCOMES FOLLOWING PHARMACOLOGICAL BRONCHIAL CHALLENGE TESTING IN NHS LOTHIAN

Laura Jess. NHS Lothian

Introduction: The use of direct and indirect pharmacological bronchial challenge testing is currently at the forefront of Primary and Secondary Care treatment pathways due to the recent NICE guidelines published in November 2017: "Asthma: diagnosis, monitoring and chronic asthma management". These guidelines have been developed to provide a diagnosis and treatment pathway for patients with suspected asthma who are under Primary Care, Secondary Care and Tertiary Services. Pharmacological bronchial challenge testing provides evidence of exclusion of asthma and ensures the appropriate management of inhaled therapy in those who have been given a clinical diagnosis.

In NHS Lothian, two methods of pharmacological challenge testing are performed; Histamine challenge (direct bronchial challenge), and mannitol challenge (indirect bronchial challenge). Due to a change in local protocol in the services that are offered to patients referred from Primary Care, the number of pharmacological bronchial challenge tests being performed by the NHS Lothian Respiratory Physiology Service have increased significantly.

The purposes of this evaluation are to ascertain trends in referral source and to identify positive response rates for direct and indirect pharmacological bronchial challenge.

Method: Patients who have undergone histamine challenge and mannitol challenge testing at the Western General Hospital, Edinburgh between 1st January 2017 and 31st July 2018 were identified (n=208) using RespNet. The referral source, positive or negative outcome of the test and PD20 (histamine) or PD15 (mannitol) were recorded for each patient who had a positive test. Trends in data were identified and discussed.

Results and Discussion: Between 1st January 2017 and 31st July 2018, n=208 pharmacological bronchial challenge tests were performed at the Western General Hospital, Edinburgh; histamine challenge n=90 and mannitol challenge n=118. Of the histamine challenge tests that were performed 100% of these were requested by Respiratory Consultants within NHS Lothian Secondary Care; 10% of these were positive (n=9) and 90% were negative (n=81). Of the mannitol challenge tests that were performed 45.8% were referred from Primary Care (n=54) and 54.2% were referred by Respiratory Consultants within Secondary Care (n=64), with a collective positive response rate of 24.6% (n=29) and negative response rate of 75.4% (n=89). The positive response rate for Primary Care referrals was 25.9% (n=14) and Secondary Care referrals 23.4% (n=15).

Histamine challenge tests have solely been requested by Respiratory Consultants within Secondary Care as a means for exclusion in patient's with suspected asthma; explaining the low positive response rate of 10%. Mannitol challenge is now being used as a diagnostic test with a higher positive response rate; collectively 24.6%. The positive response rate between Primary Care referrals (25.9%) and Secondary Care referrals (23.4%) are symmetrical, allowing patients to be treated in Primary Care, without the need for Secondary Care referral where symptoms can be managed.

EVALUATION OF HYPOXIC CHALLENGE TESTING AND ITS USES IN CHILDREN AND YOUNG PEOPLE.

Philip Lawrence. Alder Hey Children's Hospital

Introduction/background: During flight, changes in partial pressure of Oxygen can have implications on patient safety. The British Thoracic Society (BTS) has produced guidance on oxygen prescription which includes use of Hypoxic Challenge Testing (HCT) in children (Shrikrishna, D. & Coker, R.K. Thorax 2011; 66:831-833); yet clinical experience is limited in paediatric literature. Prior to May 2016, Alder Hey Children's Hospital (AHCH) did not have access to HCT and oxygen prescription was based on clinician decision alone.

Aims and Objectives: To evaluate HCT at AHCH and assess its uses to aid clinician decision making.

Methods: HCT was performed using the whole body plethysmograph method with a target FiO_2 0.15 via nitrogen dilution. S_pO_2 was measured continuously for 20 minutes and if S_pO_2 fell below protocol thresholds, oxygen was delivered via a nasal cannula. Separate protocol was used for patients with congenital heart disease. A report was given to the referring clinician, who made a flight recommendation. Kruskal Wallis H and Man Whitney U tests were used for statistical analysis and $p<0.05$ considered significant. Ethical approval was not required for this clinical evaluation.

Results: Over 26 months, 71 patients (median age 4.6 years (0.3-19.9)) were referred for HCT and all completed testing successfully. Referrals were made from Respiratory and Cardiac teams, with chronic respiratory conditions (e.g. bronchitis obliterans, interstitial lung disease, CF) (32.4%), congenital heart disease (33.8%), and asthma (8.5%) the most common indications. 22 of the 71 patients (31.0%) of were prescribed oxygen for flight as a result of the HCT. The congenital heart group had significantly lower baseline saturations ($p<0.003$) and significantly lower lowest saturations ($p=<0.005$) compared to the other groups (Table 1). Significantly more patients from the chronic respiratory conditions required O_2 during the HCT ($p=<0.001$). Non congenital heart patients prescribed O_2 had a significantly lower lowest S_pO_2 compared to those who did not require S_pO_2 during HCT (Table 2)($p=<0.001$). Similarly the congenital heart patients who required O_2 during HCT had a significantly greater drop in S_pO_2 ($p=<0.002$) compared to those who did not require O_2 (Table 4).

Conclusions: All patients who required O2 during the HCT were prescribed O2 for their flight. The results show that HCT plays an important role in clinical decision making. In our experience, all patients, regardless of age or indication, tolerated the test well. HCT gives a better understanding of physiological changes during flight and enables safer air travel.

	Chronic Respiratory	Congenital Heart	Asthma	Other	*p*-value
n	23	24	6	18	/
% Males	47.8	58.3	33.3	61.1	ns
Age (years)	7.0 (0.8-18.0)	2.6 (0.3-19.9)	12.8 (4.6-17.2)	2.8 (0.3-16.8)	*0.003*
Baseline SpO_2 (%)	96.0 [95.0-97.0]	83.0 [80.0-87.0]	98.0 [94.0-99.0]	98.0 [97.0-99.0]	*<0.001**
Lowest SpO_2 (%)	89.0 [88.0-90.0]	77.5 [73.0-82.0]	91.0 [89.0-94.0]	92.0 [91.0-93.0]	*<0.001**
% Requiring O_2	65.2	16.6	16.6	11.1	*<0.001^*

Table 1. Between diagnosis group comparisons.

Median (range) or [95% CI of Median]

*Congenital Heart significantly lower than all groups ($p<0.005$)

^Chronic Respiratory significantly higher than all groups ($p<0.001$)

	O_2 required	No O_2 required	*p*-value
n	18	29	/
% Males	61.1%	44.8%	ns
Age (years)	7.0 (0.8-18.0)	4.6 (0.3-17.2)	ns
Baseline SpO_2 (%)	95.5 [95.0-97.0]	98.0 [94.0-99.0]	*<0.001*
Low SpO_2 (%)	88.5 [88.0-91.0]	92.0 [91.0-93.0]	*<0.001*

Table 2. Comparison in the non-Congenital Heart groups between those who required O2 during HCT and those that did not.

Median (range) or [95% CI of Median]

	O_2 required	No O_2 required	*p*-value
n	4	20	/
% Males	75.0%	55.0%	ns
Age (years)	0.8 (0.3-1.6)	3.6 (0.7-19.9)	*0.013*
Baseline SpO_2 (%)	78.5 [74.0-80.0]	83.0 [81.0-89.0]	*0.016*
Lowest SpO_2 (%)	68.5 [66.0-71.0]	78.0 [76.0-82.0]	*<0.001*
% Change in SpO_2	-11.5 [-12.6- -10.4]	-6.8 [-7.6- -6.0]	*0.002*

Table 3. Comparison in the Congenital Heart group between those who required O2 during HCT and those that did not.

Median (range) or [95% CI of Median]

PREDICTORS OF PATTERNS OF RESPONSE FOLLOWING SPECIFIC INHALATION CHALLENGE TESTING WITH LOW MOLECULAR WEIGHT AGENTS

Vicky Moore. University Hospitals, Birmingham

Introduction: Little is known about the mechanisms separating early from late specific inhalation challenge (SIC) reactions. Most studies have been with IgE mediated reactions where bigger immediate reaction and greater non-specific reactivity are determinants of the subsequent late reaction. We have looked for predictors of late asthmatic reactions following SIC with mostly low molecular weight agents.

Methods: 53 workers with positive SIC to occupational agents between 2006 and 2015 were included. Non-specific bronchial reactivity (NSBR) was measured pre and post SIC. The % fall in FEV_1 during immediate reactions and NSBR were compared between those with and without subsequent late reactions.

Results: 20 workers had isolated immediate reactions, 24 had dual (immediate and late) reactions and 9 had isolated late reactions. Immediate SIC reactors had more NSBR (p=0.003), and greater falls in FEV_1 during the immediate reaction than those with dual reactions (p=0.001). Post SIC responsiveness increased more often following dual reactions, the differences (compared with immediate reactors) were not statistically significant (p=0.47). Atopics were more likely to have immediate reactions (p=0.007) but inhaled corticosteroids, baseline FEV_1 and exhaled NO did not relate to reaction type (p=0.325, 0.077 and 0.898).

Conclusions: Bigger immediate reactions and greater NSBR did not predispose to dual reactions. Inhaled corticosteroids during SIC were less frequent in isolated late reactors, but similar in those with immediate or dual reactions.

SIC reaction	NSBR		Fall in FEV1 mean (SD) %	
	Baseline	Increased post SIC	Immediate	Late
Immediate	15/20	6/20	32.4 (14.0)	8.6 (3.7)
Dual	10/24	11/24	21.3 (6.8)	21.7 (9.3)
Late	3/9	1/9	7.0 (3.3)	20.6 (8.2)

IDENTIFICATION OF SIGNIFICANT LATE REACTIONS FROM SMALLER EXPOSURES IN SPECIFIC INHALATION CHALLENGE TESTING

Vicky Moore. University Hospitals, Birmingham

Background: Specific inhalation challenge tests (SIC) are the reference standard for the diagnosis of occupational asthma. The % fall of FEV_1 post exposure required to identify clinically significant late asthmatic reactions is arbitrarily defined as >15-20%. We have used the pooled standard deviation method of Stenton[1] to provide a scientifically valid estimate of the required fall in FEV_1.

Methods: 11 workers with objective evidence of occupational asthma from serial PEF measurements at work had specific inhalation tests in hospital. Each measured FEV_1 hourly for the 3 days before SIC. The pooled standard deviation of all measurements was calculated after excluding the first hour from waking. A positive late reaction was defined as one with 2 consecutive measurements below the 95% CI for unexposed days. The research was given ethical approval from North East - Newcastle & North Tyneside 2 Research Ethics Committee REC reference: 17/ NE/0144.

Results: The mean 95% CI for control day FEV_1 was 380ml (SD 113), or 12.9% (SD 5.7%) of the baseline value. Three workers had late asthmatic reactions identified only by the pooled SD method (% fall in FEV_1 11.2%, 11.8% and 12.9%).

Conclusions: The pooled standard deviation method for defining late asthmatic reactions has scientific validity, accounts for inter-patient spirometric variability and can identify clinically relevant late asthmatic reactions from smaller exposures.

Reference:

1. ERJ 1994;7:806

HEALTH RELATED QUALITY OF LIFE IN PATIENTS WITH DYSFUNCTIONAL BREATHING REFERRED TO A CARDIOPULMONARY EXERCISE TESTING SERVICE.

Julia Rogers

Introduction: Dysfunctional breathing (DB) is a disorder characterised by an abnormal pattern of breathing. It can cause symptoms such as shortness of breath, chest pain, and dizziness. Quality of life in those with DB has not been extensively researched. The aim of this study was to use cardiopulmonary exercise testing (CPET) to identify an abnormal pattern of breathing and to aid in the exclusion of any organic disease process. We measured quality of life in those identified as having DB using the Short Form 36 Health Survey (SF-36) and the results compared to Welsh normal values extracted from the 2015 Welsh Health Survey.

Methods: We recruited eleven patients referred to a CPET service in North Wales for investigation of unexplained shortness of breath who we found to have an abnormal breathing pattern. All patients completed a symptom limited CPET. A consensus between two physiologists and a consultant physician or specialist nurse was required to label a breathing pattern as abnormal. We suggested an abnormal breathing pattern as the cause of symptoms if an erratic breathing pattern or hyperventilation was present on visual inspection of CPET data (tidal volume and respiratory rate and plot of VE vs. VT). We also observed the patient for physical signs such as upper chest breathing and breath holding. If an abnormal breathing pattern was present with no other pathology or an abnormal breathing pattern with symptoms considered out of proportion to known pathology we considered the patient to have symptomatic DB. All patients gave written consent to have their anonymised SF-36 results included in the study. Ethical approval for the study was granted by the London – Surrey Research Ethics Committee in January 2018.

Results: A Mann-Whitney U test was used to determine if there were differences in the distribution of SF36 scores between patients with DB and Welsh normal values. P was set at <0.005 to account for multiple comparisons. A retrospective power calculation gave a power of greater than 80% to detect a difference between the groups. We found SF-36 scores for patients with DB to be statistically significantly lower than for Welsh norms in all SF-36 domains. Results presented as median, interquartile range and P value. Physical functioning = 30 (33) vs. 95 (25) p= <0.005. Role Physical = 25 (28) vs. 100 (25), p = <0.005. Bodily pain = 41(20) vs. 75 (49) p = <0.005. General Health = 40 (32) vs. 72 (28) p = 0.001. Vitality = 31 (9) vs. 63 (31) p = <0.005. Social functioning = 50 (38) vs. 100 (25) p = <0.005. Role emotional = 50 (25) vs. 100 (8) p = <0.005. Mental Health = 60 (23) vs. 80 (25) p <0.004. Physical component summary score = 33 (7) vs. 53 (13) p = <0.005. Mental component summary score = 36 (12) vs. 54 (12) p = <0.005.

Discussion: The study suggests that there is an association between DB and a poorer quality of life than population norms in all SF-36 domains. Our results suggest that DB sufferers are limited from both physical and mental health perspectives and have a similar degree of impairment in QOL as those with chronic obstructive pulmonary disease (Spencer *et al*, 2001) and congestive heart failure (Jenkinson *et al*, 1997). This supports the need for recognition and support of the condition. Further research is needed to investigate the effectiveness of treatments. A consensus document on how best to diagnose and treat DB might be helpful.

SF-36 Domain	Dysfunctional breathing (this study) Mean (S.D)	Welsh normal values (WHS 2015) North Wales region aged 30+ Mean (S.D)	COPD (moderate-severe based on post-bronchodilator FEV_1) - mean (S.D) Spencer *et al* 2001)	Congestive heart failure (symptomatic patients 60 years and over) Mean (SD) Jenkinson *et al* 1997)	Hyperventilation Syndrome (Chenivesse *et al*, 2013) Mean (SD)
PF	36.36 (24.81)	80.59 (28.11)	40 (26)	41.45 (25.01)	44 (24)
SF	47.73 (23.60)	81.96 (27.01)	69 (28)	73.68 (28.58)	57 (27)
RP	26.70 (18.77)	81.39 (29.42)	40 (42)	32.24 (40.65)	21 (32)
RE	46.97 (17.19)	88.66 (23.90)	59 (43)	67.54 (45.51)	48 (42)
MH	60.09 (15.53)	74.77 (19.66)	70 (18)	77.37 (19.42)	51 (27)
VT	31.82 (17.78)	57.94 (23.18)	46 (21)	51.45 (22.02)	34 (20)
BP	38.09 (17.32)	71.79 (27.17)	73 (27)	78.65 (27.14)	41 (21)
GH	41.45 (23.34)	67.01 (23.27)	40 (21)	61.08 (20.67)	42 (21)
PCS	34.26 (7.40)	48.80 (11.22)	35 (10)	-	-
MCS	38.93 (6.97)	50.40 (11.12)	49 (11)	-	-

Supporting Data. SF-36 scores in different patient groups – Mean (SD)

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IDENTIFICATION OF SIGNIFICANT LATE REACTIONS FROM SMALLER EXPOSURES IN SPECIFIC INHALATION CHALLENGE TESTING

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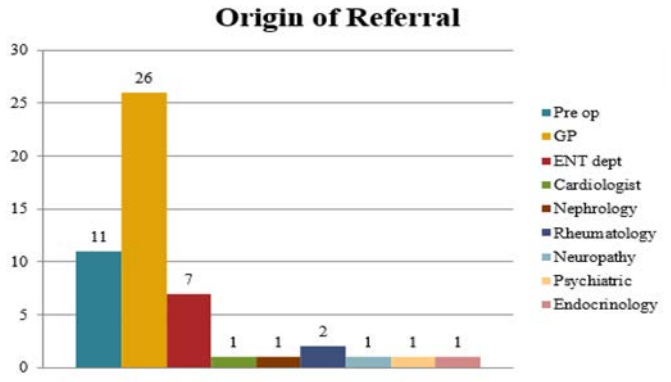
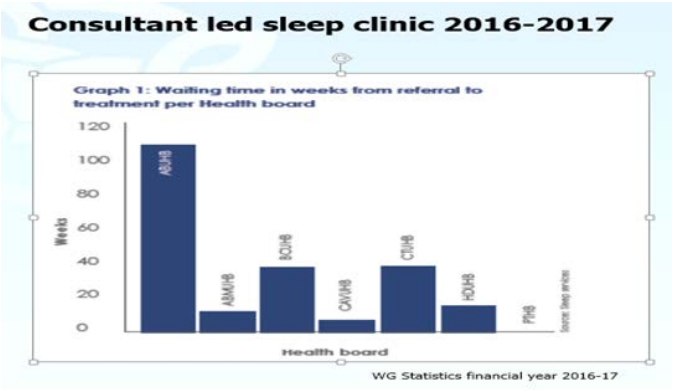
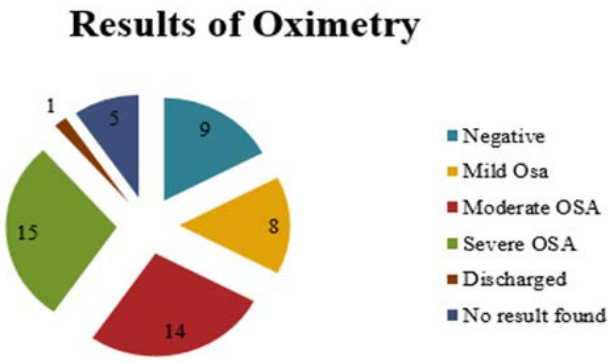
Aims: The aim is to undertake a service evaluation of a Physiologist-Led sleep clinic to examine the outcomes of the cohort, the reduction of RTT and improvement in access to HCP.

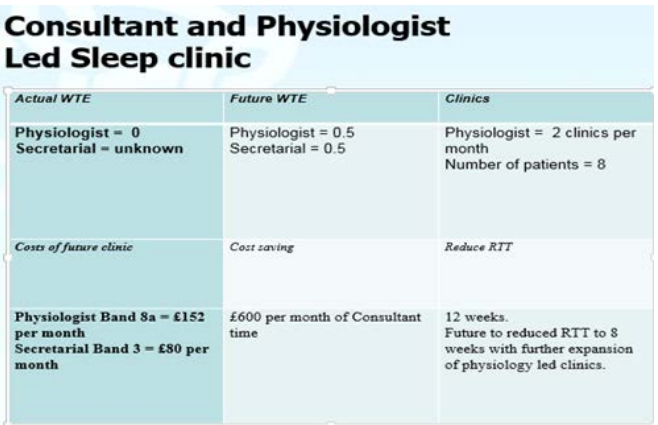
Methodology: Evaluating the annual database of a cohort of 51 patients reviewing whether the waiting times decreased and allowed quicker access to diagnosis and therapy. Reviewing the database to evaluate the origins and benefits of the Physiologist's autotomised clinic.

Results: From this cohort, majority of patient referrals were from General Practitioners with a ratio of 59% Male to 41% Female and the mean BMI was 38.5. 80% of patients were drivers with majority of patients having Class 1 license, only two had Class 2 license for their occupation. The results showed 72% were classed as positive for OSA with 17% were negative on pulse oximetry. 59% were successfully treated with CPAP therapy; 3% referred for MAD; 31% awaiting further sleep investigation.









Conclusion:

- Achievement of the reduction in Waiting times from 38 weeks to 12 weeks, of patients with symptoms of OSA being reviewed by a Healthcare Professional.
- Developing Physiologist–led sleep clinics is a more cost effective solution to patient clinical review, diagnosis and treatment with a cost reduction of £340/month to the HB.

A COMPLEX SLEEP APNOEA CASE: ROLE OF ENHANCED TECHNOLOGY AND REMOTE MONITORING

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Introduction: Complex sleep disordered breathing can be difficult to detect and treat. Quicker, more accurate and more detailed therapy data can aid quantitative and qualitative identification of central or complex sleep apnoea, and aid escalation of therapy to adaptive servo ventilation (ASV) when indicated (Randerath 2017).

Methods: Presented are different resolutions of therapy data from a single case (patient DO) on APAP and ASV.

Results: DO was diagnosed with sleep-disordered breathing with ODI of ~50/hr and prescribed APAP, with acceptable mask leak but raised residual AHI/CAI (~39 /19/hr) and CSR flags (33%) from auto-scoring (Fig 1). Examination of flow waveform from this night shows waxing/waning typical of Cheyne Stokes respiration (CSR) (Fig 2).

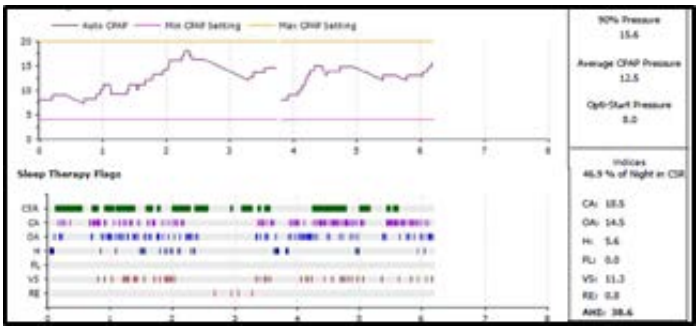

Fig 1: Daily details from APAP night

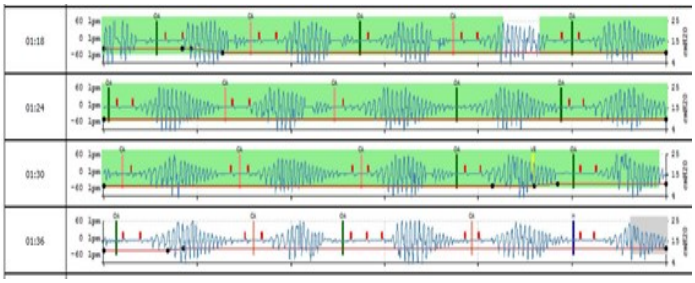

Fig 2: Flow Waveform from same APAP night

After 3m, echocardiogram showed LVEF >45% and DO commenced on ASV, with representative daily details and flow waveform in figs 3 and 4. Autoscored AHI and CSR on ASV were reduced to ~6/hr and ~3% respectively. Fig 4 shows ASV pressure support and back-up breaths activating and de-activating in response to patient flow, counter-balancing an underlying CSR pattern.

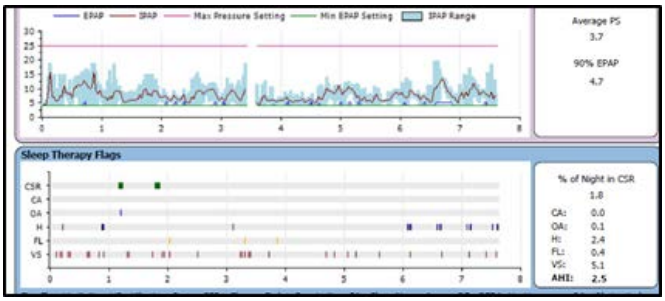

Fig 3: Daily details on ASV night

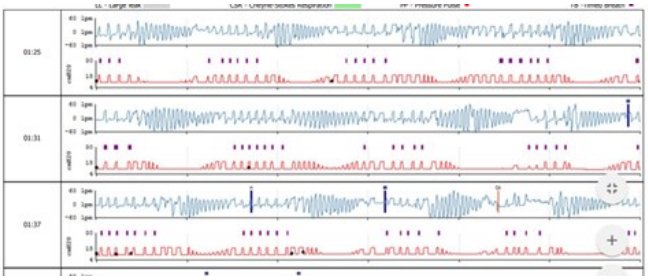

Fig 4: Flow Waveform from ASV night

Conclusions: Remote technology enables timely and detailed data review by clinical specialists, aiding qualitative as well as number -driven clinical care.

References:

W. Randerath *et al*. ERJ Open Res. 2017 Oct; 3(4): 00078-2017.

CAN WE TRUST AUTOMATIC ANALYSIS OF NOX T3?

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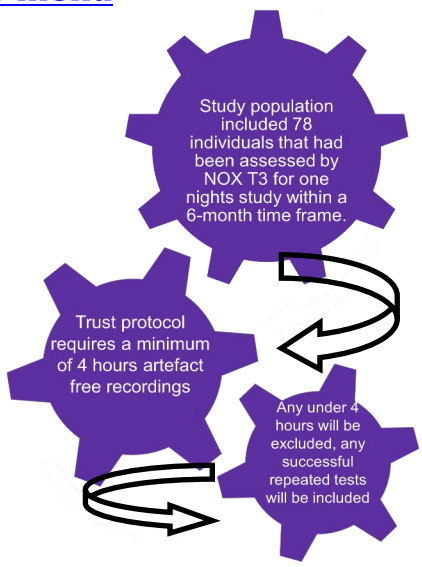
Introduction: Nox T3 is a portable sleep monitor used for diagnosing and monitoring sleep apnoea by calculating values such as apnoea/hypopnoea index (AHI) and oxygen desaturation index (ODI). Sleep apnoea is a disorder whereby frequent collapsing of the upper airways results in significant oxygen desaturations and pulse rate rises throughout the duration of sleep. As listed by the American Academy of Sleep Medicine, high blood pressure, heart disease, stroke and depression are amongst the main long term health impacts of untreated sleep apnoea.

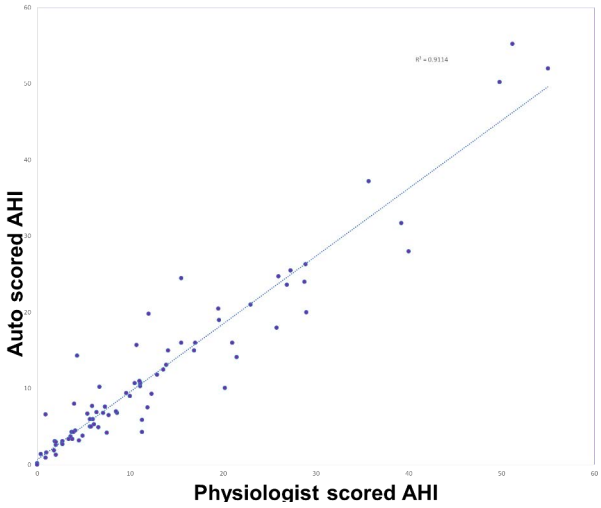
Objectives: The trust protocol states the NOX T3 multi-channel recording should be performed for one nights study to either confirm or refute the presence of sleep apnoea when diagnostic pulse oximetry proves inconclusive.

The aim of the project was to retrospectively evaluate the accuracy in automated analysis of the NOX T3 recordings compared with manual physiologist hand scoring to determine whether the NOX T3 can accurately analyse the overnight recordings. If so, this would establish trust within the software's capabilities knowing that accurate analysis is safely determining correct disease management for the patients, as well as freeing up valuable physiologist time.

Methods & Results : Because repeated measures were assessed n the same individual for both automated and manual scoring, the Pearson's correlation coefficient was calculated from the spread between AHIs which gave a result between 0.99 and 0.96 for ODI showing an excellent association grade between both scoring methods. Bland-Altman plot was used to assess agreement between the scoring systems and showed s mean difference of 0.68 with limits of agreement between 6.3 to 7.6 events/hour for AHI and 0.06 with agreement ranging from 2.2 to 2.3.



Scatter Plot of Auto and Physiologist-Scored NOX T3 AHI



	Auto Scored	Physiologist Scored
AHI < 5	37	37
AHI ≥ 5 - 15	49	49
AHI ≥ 15 - 30	23	23
AHI ≥ 30	10	10

Discussion: From the scatter plot to the left, a strong linear relationship can be confirmed by the R value of 0.91 between automatically scored AHI with physiologist hand scoring. The results showed that the NOX T3 had a high degree of sensitivity in correctly identifying the presence of an apnea. Previous studies showed similar findings with R values of 0.93 comparing auto and manual scoring. In comparing automated analysis with manual physiologist hand scoring the results showed no statistical significant difference, excellent correlation and an acceptable agreement level between both methods of scoring and validated the diagnostic accuracy of the NOX-T3.

ARTP Association for Respiratory Technology & Physiology

ARTP National Strategy Day for leaders in respiratory/sleep physiology, Friday 6th September 2019 at The Birmingham, Hilton Metropole