O1

01 - Relationship between Volatile Organic Compounds in breath determined by Proton Transfer Mass spectrometry, clinical characteristics and airway inflammation in COPD

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Background
Chronic obstructive pulmonary disease (COPD) is a heterogeneous condition. Breathomics presents an opportunity to phenotype this heterogeneity but how breath volatile organic compounds (VOCs) relate to clinical features, airway physiology and inflammation is uncertain.

Methods
We undertook a single centre prospective study in subjects with moderate to severe COPD. We assessed 379 breath samples obtained at stable visits. The breath VOCs were examined using Proton Transfer Reaction-Time Flight-Mass Spectrometry (PTR-TOF-MS). Principal component analysis (PCA) and partial least squares discriminant analysis (PLS-DA) models were undertaken to determine whether there were distinct VOC profiles associated with spirometry, plethysmography lung volumes, gas transfer, symptoms (mMRC and CAT questionnaires), sputum eosinophils (< versus ≥1%) and neutrophils (< versus ≥61%).

Results
34 COPD subjects were studied of which 8 were women. The subjects had a mean age 70 (66-74) years and FEV1 52% predicted (32.2-72.3%). There were no distinct VOC breath profiles that were associated with airway physiology or symptoms. The sputum eosinophil and sputum neutrophil cut-offs did identify distinct profiles with a receiver operator characteristic (ROC) curve area-under-the-curve (95% confidence intervals) 0.84 (0.77-0.86) and 0.80 (0.69-0.81) respectively.

Conclusion
VOC breath profiles are related to airway inflammation but not physiology or symptoms in COPD.

O2

O2 - A clinical quality improvement project on assessing co-existing nocturnal hypoventilation alongside obstructive sleep apnoea

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Authors: Shirley Coelho, Elizabeth Green, Allan- Alhelou, Rahul Mukherjee

Title

A clinical quality improvement project to assess co-existing nocturnal hypoventilation alongside obstructive sleep apnoea

Background

Nocturnal hypoxia and obstructive sleep apnoea (OSA) are associated with increased risk of atrial fibrillation, hypertension and increased risk of diabetes. However, OSA is typically treated as an isolated pathology. An original survey in our department showed that, due to lack of clear guidance, failure to recognise hypoventilation leads to underdiagnosing conditions like OSA/COPD and OSA/OHS overlap[1].

Aim

To assess how many patients with a diagnosis of obstructive sleep apnoea that spend > 20% of the night with SpO2 below 90%, were followed up with an overnight oximetry once on CPAP. This is to ascertain the need for NIV and/or supplemental oxygen.

Method

We performed an internal audit to check how many patients with severe OSA were followed up with overnight oximetry once settled on CPAP. Patients that had an AHI > 30 and SpO2 < 90% for more than 20% of the night were included.

Results

A total of 1632 studies were performed between July 2018 and July 2019. 382 (23%) had severe OSA; in this severe OSA group, 174 individuals (45%) spent > 20% of the night with SpO2<90% and 131 (34%) spent >30% of the night SpO2 < 90%. In the group of patients with a significant time spent under 90%, only 15 individuals (8%) were followed up with overnight oximetry on CPAP and 4 (27%) of those were managed with CPAP pressure increase and still showed evidence of hypoventilation.

Conclusion

At the time of the first audit cycle, none of the patients that fit the above criteria were identified. By raising internal awareness during departmental meetings, there was some recognition of nocturnal hypoventilation. Through the period of the second audit cycle, the number of overnight oximetry tests on CPAP increased by 62%. Further guidance on how to manage this group of patients is needed.

Reference: Cachada N, Daniels M, Chakraborty B, et al. The strength of association of nocturnal hypoventilation with severity of sleep apnoea. ERJ 2016; 48:PA2200

O3

03 - Impact of a multidisciplinary approach to delivering acute NIV in a large teaching hospital.

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Impact of a multidisciplinary approach to delivering acute NIV in a large teaching hospital.

Introduction

Acute non-invasive ventilation (aNIV) is a well evidenced treatment for acute hypercapnic respiratory failure (AHRF) in COPD and other conditions including obesity hypoventilation syndrome, restrictive chest wall conditions and neuromuscular diseases. Within our service we recognised similar challenges and outcomes highlighted by NCEPOD's 'Inspiring Change' document. In response to this and utilising BTS Quality Standards, we undertook a quality improvement project (QIP), introducing a multidisciplinary aNIV team including the skills of Clinical Scientists, Physiologists, Physiotherapists and Nurses. We present results from our first dataset.

Methods

This is a retrospective study of patients who commenced aNIV according to local policy at a large university teaching hospital over a 6-month period. Outcome variables were based on BTS Quality Standards and reviewed
using NCEPOD audit toolkit. In addition, physiology data, inpatient mortality, 30-day mortality and readmission rates were recorded.

Results

Our patient cohort (47) was predominantly COPD patients (79%) with a mean pH of 7.25 (NCEPOD cohort; COPD 69%, pH 7.25). Mean referral to mask time was 22 minutes, with 80% seen and treated by aNIV team within 1 hour (30% prior to aNIV team). In total 30% of patients had a pre-NIV pH <7.25 and 16% <7.15. ABG sampling at 1hr of NIV was completed in 97%. A total of 85% had an improved pH and 87% pC02 at 1hr of NIV (range .01-.26; .16-6.29kpa, respectively) with complete reversal of respiratory acidosis in 17% of patients.

In-patient mortality was lower than NCEPOD cohort and our previous audit (16%; 35%; 28%, respectively), 30-
day mortality was 0% with a 14% 30-day re-admission rate. Assessment against BTS Quality Standards are shown in Table 1.

Discussion

Our data shows that an aNIV MDT utilising NCEPOD toolkit is able to deliver BTS quality standards to a large percentage of patients and contribute towards a reduction in inpatient mortality. A well-defined aNIV pathway,
dedicated on-call rota, specific proforma and robust staff competency framework contribute towards achieving
these outcomes. Future research is required in order to fully understand the mechanisms by which further improvements in patient outcomes can be achieved.

Treating the right patients: Is NIV indicated? 96 Amber
Making a ceiling of treatment decision or escalation plan before
starting NIV.
87 Amber
Documenting NIV settings and the adjustment in settings in

response to new information
100 Green
Starting NIV within 60 minutes of the decision to treat with NIV
80 Amber
Continuous monitoring of the patient over the first 24 hours or until the initial respiratory acidosis has resolved
75 Amber
Staff training and competency 100 Green
Table 1 - British Thoracic Society (BTS) Quality Standards

O4

04 - Validation of nitric oxide transfer factor predicted equations and the impact of posture.

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Title: Validation of nitric oxide transfer factor predicted equations and the impact of posture.

Introduction: Predicted values for the combined simultaneous measurement of TLNO and TLCO ($TL_{NO,CO}$) are available[1,2]. We aimed to validate these equations in a previously untested population.

Increasingly lung function measures are compared to functional magnetic resonance imaging obtained with the patient supine. We aimed to examine the effect of postural changes from seated to supine on $TL_{NO,CO}$.

Methods: 98 healthy volunteers performed spirometry and $TL_{NO,CO}$, a subgroup additionally performed $TL_{NO,CO}$ whilst supine. Measured $TL_{NO,CO}$ values were compared to predicted[1,2]. A mean z-score and standard deviation (SD) of 0 and 1 respectively indicated a good fit to predicted values. Bland Altman plots assessed agreement between measured and predicted. Percentage change was used to identify difference between seated and supine values.

Results: Volunteers were aged 18.5-82.8 years. Using GLI spirometry and TLCO equations, measured values fit well against the normal distribution (mean (SD)) z-score; FEV1 -0.1(0.9), FVC=0.2(0.8), FEV1/FVC=-0.4(0.94) and TLCO=-0.2(0.7). Using Zavorsky equations[1], mean(SD) z-score; TLNO=-1.6(0.7), TLCO=-1.0(0.7). Using Munkholm equations[2], TLNO=-1.4(0.9), TLCO=-1.2(0.9). Measured $TL_{NO,CO}$ compared to Zavorsky predicted[1] was lower with a bias of -11.0 and -1.3mmol.min.kPa for TLNO and TLCO respectively. Measured $TL_{NO,CO}$ compared to Munkholm predicted[2] was lower with a bias of -6.3 and -1.3mmol.min.kPa for TLNO and TLCO respectively. 31 subjects performed $TL_{NO,CO}$ whilst supine. Both TLNO and TLCO values significantly increased ($p<0.001$) when supine by 3% and 7% respectively.

Conclusion: Published predicted equations for $TL_{NO,CO}$ over-estimate gas exchange measurement in this healthy population and therefore may not be appropriate for local clinical use.

$TL_{NO,CO}$ increased when supine suggesting comparisons between seated lung function and supine radiologic images should be made with care.

References

1. ZAVORSKY, G. S., HSIA, C. C. W., HUGHES, J. M. B., BORLAND, C. D. R., GUÉNARD, H., VAN DER LEE, I., STEENBRUGGEN, I., NAEIJE, R., CAO, J. & DINH-XUAN, A. T. 2017. Standardisation and application of the single-breath determination of nitric oxide uptake in the lung. *European Respiratory Journal,* 49.

2. MUNKHOLM, M., LOUIS MAROTT, J., BJERRE-KRISTENSEN, L., MADSEN, F., PEDERSEN, O. F., LANGE, P., NORDESTGAARD, B. G. & MORTENSEN, J. 2018. Reference equations for pulmonary diffusing capacity of CO and NO in adult Caucasians. *Eur Respir J*.

P2

P2 - Cardiopulmonary Exercise Testing Service Utilisation: Service Development

Mr Max Thomas[1], Dr Vicky Moore[1], Ms Shirley Coelho[1]
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Title: Cardiopulmonary Exercise Testing (CPET) Service Utilisation: Service Development CPET Service UtilisationVascularGastroRespiratoryThoracicUrologyCardiologyENT050100150200250 2017-182018-19Number of Referrals

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. Use of CPET as a diagnostic tool can pre-empt invasive, expensive and potentially unnecessary assessment without definitive diagnosis (Thing et al. Thorax 2011; 66 (4): A144). An audit in 2018 highlighted that the service at Birmingham Heartlands Hospital was underutilised for diagnostic purposes. Efforts were made to promote the service through initiating joint clinics, attending MDTs, giving talks in local research meetings/journal clubs.

Methods: We conducted a retrospective analysis of CPET referrals between June 2018 and May 2019, and compared with those of the previous 12 months. The source of referral and clinical indication were recorded and presented.

Results: Total referrals for CPET were 456 in 2018-19 compared to 307 in 2017-18 (see figure) indicating a 32.7% increase. The majority of referrals were for surgical disciplines rather than medical disciplines in both time periods (326 vs 130 in 2018-19; 268 vs 59 in 2017-18); however the proportion of tests for diagnostic purposes has increased by 9.3% (28.5% in 2018-19 vs 19.2% in 2017-18). Vascular surgery was the largest source of referrals in both time periods (47.6% of total referrals in 2018-19; 46.8% in 2017-18). In the 2018-2019, the total number of CPET referrals from cardiology and respiratory has increased by 327% and 197% respectively. Referrals from cardiology now equate to 7.9% of all referrals to the CPET service, and respiratory equates to 20.4% of all referrals.

Discussion: The CPET service has experienced a large increase in the number of referrals after continued effort to increase service uptake. Preoperative assessment remains the primary referral type – predominantly vascular surgery. The effort to improve utilisation of CPET for diagnostic purposes has improved the rate of referral from cardiology and respiratory medicine, disciplines that would benefit most from the service. The continued growth of the service is evident. The future growth will rely on development of the workforce and continued promotion of the service.

P3

P3 - Audit of GP Spirometry Services in Cheshire West

Miss Marie Hardy[1]

[1]*Countess Of Chester, Chester, United Kingdom*

Abstract: Audit of GP Spirometry Services in Cheshire West

Category A

Aim: Ascertain which GP practices offer a spirometry service, how frequently spirometry is performed and the qualifications/ registration of staff performing spirometry in comparison to national standards.

Method: Audit approval was obtained from the Clinical Lead and the Countess of Chester R&D department, a questionnaire was developed and sent to all 33 GP practices in Cheshire West to be completed and returned to the R&D department.
The audit looked at 4 elements 1.Does the practice perform spirometry testing, 2. Which Health Care professionals (HCP) perform the tests, 3. Calibration of equipment, 4. Interest in a community spirometry service/ training information

Results: Of the 33 questionnaires sent 16 were returned (52% response rate)

1. All practices stated that they provided a spirometry service. However; the frequency in which spirometry was performed varied from daily (56%), weekly (33%), monthly (6%) and adhoc (25%).

1. From those that completed questionnaires, a total of 23 HCP performing spirometry were identified, 20 practice nurses and 3 health care assistants. None of the practices had GPs or any other HCP performing spirometry. It was also found that only 9 of these healthcare providers had received training within the last 3 years and furthermore only 3 of these were on the ARTP spirometry register (13%). *See figure 1*

2. The calibration and/or verification of the equipment used in the GP practices is variable between the practices from daily to never.
3. 90% of the practices would be interested in a community based spirometry service overseen by COCH

Discussion: From the study it can be seen that the standard of training of those performing diagnostic spirometry is poor with only 40% of those that replied having received any training in the past 3 years and currently only 3 HCP from our responding practices are on the ARTP register of certified spirometry providers**.** Cheshire west CCG estimates approximately 2000 diagnostic spirometry tests are performed each year across the area.

Following on from this audit a community spirometry service has now been developed and is in the process of being implemented in stages across the Cheshire west area.

Is this a pilot Study?	No
Does this study use human subjects, human biopsy specimens or genetic material?	No

P4

P4 - PCT Community Spirometry - A physiology led service Evaluation.

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ARTP Abstract:
Aim/Introduction: To evaluate the physiology led spirometry service provided for the community respiratory team (CRT) on behalf of GP practices within the North Staffordshire CCG. Appointments for Spirometry are booked within 2 weeks of referral. Patients attend a local health centre. Spirometry, MRC score, pulse oximetry and inhaler technique are assessed.
Methods: A six month period was evaluated. Utilisation of the service capacity was addressed. The classification of spirometry and total number of referrals into secondary care were measured. A comparison of a current diagnosis and any new diagnosis were also analysed.
Results: Spirometry clinics are held at 5 locations with clinic utilisation at 78% of capacity. This was largely due to DNA's (20%) and a small portion of last minute cancellations (2%). 307 (60%) of the 513 patients seen had 'normal' spirometry. A referral to a tier 4 service was advised in only 9% of cases. The remaining 81% of patients were managed within a tier 2/3 service. What is clear is that a 'label' of a diagnosis is less important than the severity of abnormality present. Referral rate increased with deteriorating spirometry. In 4% of cases where the spirometry was considered 'normal', a referral was still advised for a number of reasons, thus highlighting the importance of measuring additional outcomes in conjunction with spirometry testing.

Conclusion: The high number of DNA's needs to be improved. Following the audit, the CRT admin will be sending an 'opt-in' appointment letter in which patients contact them to make an appointment that is convenient. The service will be re-audited in 3 months' time to gauge progress. The spirometry service appears to provide a cost effective approach in which unnecessary referrals into secondary care are avoided; whilst patients that require further management than that offered by their GP they remain under the tier 3 CRT.

P5

P5 - Evaluation of the growth and development of a new south London paediatric respiratory physiology service

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AIM: Evaluation of the growth and development of a new south London paediatric respiratory physiology service
Methods: Test type, number performed and sleep referrer information was collected retrospectively between January 2015 and June 2019 from hospital electronic record systems.
Results: 9786 lung function tests were performed. Spirometry yielded the largest number of tests at 4645 with Fractional exhaled Nitric Oxide and reversibility testing at 50.6%, which relates to our one stop clinic service offered. Specialist tests however have remained low, reducing from 2.67% to 0.86%. A plateau for number of lung function is starting to emerge.
Total number of sleep studies increased by 282% in first 6 months of 2019 when compared with whole of 2015. Pulse oximetry studies, accounted for 42% of total tests in 2019, of which 46% of referrals were from ENT services. External ENT referrals have steadily increased, suggesting an increased awareness of service and implementation of the tonsillectomy guidelines. Complex respiratory sleep studies have increased. Staffing levels increased in 2018 from 0.5 to 1.5wte, coinciding with the largest increase in number of test performed between years.
Table 1: Number and type of tests performed and where sleep studies are referred from.

	2015	**2016**	**2017**	**2018**	**2019**
Type of Test	Number of tests performed				
PSG	8	25	56	63	52
TOSCA	105	108	195	275	131
Overnight Pulse Oximetry	0	0	6	174	136
Spirometry	710	937	1053	1279	669
Reversibility	138	159	142	273	122
FeNO	629	755	957	1160	580
Full Lung Function *Spirometry *Gas Transfer *body plethysmography	41	30	34	34	12
Specialised Tests *STEP TEST *Nasal NO *Muscle Pressures	14	17	8	24	9
Type of referrer	Percentage of referrals from total number of sleep studies				
Respiratory	21%	46%	60%	54%	48%
ENT	43%	30%	24%	20%	26%
External ENT	9%	10%	5%	13%	20%
Other	27%	14%	13%	13%	5%

Conclusions: The review demonstrates a significant demand on a paediatric physiology service in South London. The evaluation highlights the importance to review services regularly and recognise areas and opportunities for further development. Considerations for exponential growth include evaluation of peripheral services, clinic capacity, space, equipment availability and number of staff, considerations which may also hinder future growth if not addressed. Lower than expected numbers for full lung function and

specialised tests, given the increase in specialised clinics demonstrates underutilisation. This suggests the need for further education, awareness of the range of physiological tests already available and tests which could be implemented such as hypoxic challenge testing.

P6

P6 - Bronchoprovocation testing in patients with asthma-type symptoms: worth taking a breath in?

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Bronchoprovocation testing in patients with asthma-type symptoms: worth taking a breath in?

Background

Direct bronchoprovocation testing (BPV) has an established role in the assessment of asthma-type symptoms[1]. Measurement of FEV1 following exposure to escalating doses of inhaled histamine or methacholine can be used to assess the presence of lower airway hyper-responsiveness (AHR). Some centres have used this test to evaluate the presence of extra-thoracic airway hyper-responsiveness (EAHR), based on changes in the inspiratory flow[2]. We have utilised this approach at the Royal Brompton Hospital (RBH) for several years and the aim of this work was to assess the value of obtaining inspiratory flow measures during BPV.

Methods

Data was retrospectively evaluated from individuals who underwent BPV with histamine (Jul '14 – Mar '15) or methacholine (Oct '18 – Sept '19). AHR was defined by a 20% dose-responsive fall in FEV1 ($PC20FEV_1$) in response to ≤8 mg/ml histamine or methacholine. EAHR was defined as a 25% reduction in FIF50 (PC25FIF50) in response to ≤8 mg/ml histamine or methacholine, or ≤16 mg/ml. Symptoms were evaluated at each dose with a Borg score ≥3 taken as positive.

Results

We studied 142 patients; 65% (n=92) underwent histamine BPV (mean ±SD; age 45.6 ± 16.4 years, BMI 28.3 ± 6.1 kg/ m^2, 70% female, n=64) and 35% (n=50) underwent methacholine BPV (mean ±SD; age 40.2 ± 13.8 years, BMI 27.0 ± 5.7 kg/ m^2, 80% female, n=40). For the patients tested with histamine evidence of AHR was found in 7 patients (7.6%) and EAHR in 10 patients (10.9%). Of the latter group, EAHR was found at ≤8 mg/ml in 5 patients (50.0%) and at ≤16 mg/ml in 5 patients (50.0%), and in 4 patients (40.0%) this was in a dose-responsive way. Of the 142 patients, 42 (45.7%) reported symptoms and in 34 (81.0%) of these, symptoms were dose-respondent (worsened through the test). The prevalence of AHR, EAHR and symptom development was similar with methacholine BPV. Patients with evidence of EAHR with histamine were older when compared with the methacholine group (40.9 (standard deviation 14.2) v 31.2 (17.0) years; unpaired *t* test: P=0.26). Those with EAHR in the histamine group had a slightly higher BMI (27.9 (SD 6.4) v 25.8 (1.3) kg/ m^2; Mann-Whitney U test P=0.68).

Conclusion

The prevalence of AHR and EAHR to direct BPV agents is similar and approximately 1 in 10 results was positive. Despite this, almost half of patients developed respiratory symptoms during BPV.

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2. Bucca C*, et al*. Histamine hyperresponsiveness of the extrathoracic airway in patients with asthmatic symptoms. *Allergy.* 1991;46:147–53

Characters: 1,996

P7

P7 - 200 mcg versus 400 mcg BD - is there a real difference?

Mr Mark Hardyman[1], Dr Adrian H Kendrick[1]

[1]*University Hospitals, Bristol, Bristol, United Kingdom*

The use of bronchodilator therapy is essential in assessing the potential reversibility of airway function. The choice of which bronchodilator type and the dosage are two key factors in determining the overall response. In this study we have retrospectively analysed data in a group of patients given 200 mcg of salbutamol and in a separate group given 400 mcg. The response to the difference doses was assessed using the change in FEV_1 and in FVC as a percentage of predicted value, thereby standardising for age, height and sex.

2466 subjects (45% Male) aged 53 ± 17 years were assessed for 200 mcg. Mean FEV_1 pre-BD was 2.4 ± 0.96 L rising to 2.5 ± 0.99 L post BD. The %predicted change was 2.7 ± 7.5%. For FVC the values were 3.4 ± 1.16 L rising to 3.45 ± 1.17 L. The %predicted change was 1.3 ± 9.8%.

For the 400 mcg group 159 subjects were assessed (48% male), aged 55 ± 16 years. Mean FEV_1 pre-BD was 2.36 ± 0.87 L rising to 2.46 ± 0.9 L post BD. The %predicted change was 3.7 ± 6.5%. For FVC the values were 3.4 ± 1.04 L rising to 3.48 ± 1.08 L. The %predicted change was 1.53 ± 8.8%.

There was no significant difference between the responses for either FEV_1 or FVC when using the change as a %predicted. Within the limitations data analysis, these results suggest that there does not appear to be any significant advantage of giving 400 mcg as compared to 200 mcg. Ideally a direct comparison of doses should be undertaken in the same subject, on different days, which might provide a better insight as to the importance of BD dose.

P8

P8 - A retrospective analysis of patients referred for two different bronchial challenge tests between January 2016 and August 2018.

Mrs Nikki Williams[1]
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A retrospective analysis of patients referred for two different bronchial challenge tests between January 2016 and August 2018.

Background: Asthma affects over three hundred million people worldwide (GINA, 2018). It is characterised by airflow obstruction, which varies over time and in severity, with concomitant airway inflammation and hyperreactivity (an exaggerated response to a range of allergic and environmental stimuli) *(*BTS/SIGN, 2016; Busse, 2012). Bronchial challenge tests (BCTs) are recommended by national and international clinical guidelines for the diagnosis of asthma. The two investigations most commonly used to identify airway hyperreactivity (AHR) in clinical practice are methacholine and mannitol bronchial challenges. Concern over the diagnostic accuracy and reliability of bronchial challenge tests within the respiratory physiology department provided the driver for this project.

Aims: To characterise and compare patients referred for methacholine or mannitol challenge tests over 24-months. Objectives were to analyse data within and between groups to detect potential predictors of reactivity and develop an algorithm for selecting the best bronchial challenge method, based on patients' clinical characteristics.

Methods: Demographic data, bronchial challenge, spirometry, blood eosinophils, IgE, FENO, asthma medication, symptoms, reason for referral, and final diagnosis, were obtained for 72 adult patients referred for bronchial challenge. Patients were grouped into, non-reactive (n=45), methacholine-reactive (n-18) and mannitol-reactive (n=9). Data were analysed for associations with reactivity.

Results: Significant associations were found between shortness-of-breath (p=.013), cough (p<.001) use of ICS (p=.009), SABA (p=.015), oral steroids (p=.022), and methacholine-reactivity. Lower FEV_1 % pred (p=.003), FEV_1/FVC (p=.029), and PEF % pred (p=.020) were significantly associated with mannitol-reactivity.

Reactive patients were more likely to be diagnosed with asthma (p<.0001). No significant relationship was found between reason for referral, FENO, blood eosinophil count, or IgE and reactivity to either bronchial challenge.

		Reactivity Group (n)			
		Non-reactive (45)	Mannitol Positive (9)	Methacholine Positive (8)	*P=*
Allergic / Inflammatory Markers	Blood eosinophils (g/l)	0.2 [0.175-0.4]	0.2 [0.1-0.25]	0.4 [0.1-0.3]	*NS*
	Total IgE (Ku/l)	90.0 [20.5-207.25]	116.00 [41.25-1530.25]	69.00 [38.50-161.50]	*NS*
	FENO (ppb)	17.0 [10.0-29.0	15.50 [8.50-24.75]	18.50 [9.50-61.75]	*NS*
Diagnosis (% of group)	Asthma confirmed	0	56	39	*p<0.0001*
	Asthma excluded	44	33	6	
	No follow-up	56	11	44	
Presenting Symptoms (% of group)	SOB	31	67	67	*p=0.013*
	Cough	24	22	78	*p<0.001*
	Wheeze	27	33	39	*NS*
	RRTI	13	11	17	*NS*
Reason for referral (% of group)	Query asthma	18	22	33	*NS*
	Asthma	18	33	39	
	Cough or bronchitis	13	11	6	
Asthma treatment	Oral steroid	24	33	61	*p= 0.022*
	ICS	56	78	94	*p=0.009*

(% of group)	SABA	38	56	78	*p=0.015*
Spirometry	*FEV_1 (% pred) (l)	97.3 [17.5]	76.9 [14.8]	89.5 [15.0]	*p=0.003*
	*FVC (% pred) (l)	107.2 [15.8]	97.9 [21.1]	102.4 [17.9]	*p=0.244*
	*FEV_1/FVC (%)	78 [69.5-80.8]	68 [60.6-75.4]	73.2 [70.0-77.3]	*p=0.029*
	*PEF (% pred) (l/m)	102.3 [19.6]	84.4 [12.3]	94.1 [19.0]	*p=0.020*

Table 1: Results

Abbreviations: SOB – Shortness of Breath; RRTI – Recurrent Respiratory Tract Infections; ICS – Inhaled Corticosteroid; SABA – Short Acting Beta Agonist; FEV_1 (% pred) - Forced Expiratory Volume in one second as a percentage of the predicted value; FVC (% pred) – Forced Vital Capacity as a percentage of the predicted value; FEV_1/FVC – Forced Expiratory Ratio; PEF (% pred) - Peak Expiratory Flow as a percentage of the predicted value IgE – Immunoglobulin E; FENO – Fractional Exhaled Nitric Oxide

Conclusions: Methacholine challenge identified asthma in patients prescribed asthma treatments with characteristic symptoms. Mannitol detected airway hyperreactivity in patients with reduced lung function. Additional clinical information may help in selecting appropriate challenge methods for individual patients.

1. BTS/SIGN, (2016). SIGN 153 British guideline on the management of asthma, [Online].
1. Busse, W. W. (2012) 'What Is the Best Pulmonary Diagnostic Approach for Wheezing Patients With Normal Spirometry ?', *Respiratory Care* Vol 57 pp. 39–50 [Online

Is this a pilot study? ~~YES~~ / NO

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

*If YES, please provide evidence that ethics committee approval has been obtained, where necessary. This study was an anonymised, retrospective, descriptive study. Ethics approval was not required by the health board.

P9

P9 - Does spirometry alone capture all respiratory abnormalities associated with abnormal lung function?

Mr Ross Beech[1], Mr Luke Youngs[1], Mr Matthew Rutter[1], Dr Karl Sylvester[1]
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Does spirometry alone capture all respiratory abnormalities associated with abnormal lung function?

Introduction and Objectives

Respiratory disease is the third biggest cause of death in the UK (1), and for the first time, NHS England (NHSE) has designated respiratory disease as a clinical priority. The NHSE Long Term Plan highlights earlier and more accurate diagnosis as an objective. To identify respiratory disease earlier, the plan relies on quality performance of spirometry within the primary care setting. However, lung gas exchange abnormalities can be present in lung disease despite normal spirometry (2). Therefore, some diagnoses may be missed. Our aim was to investigate within a cohort of our patients, the proportion of those with abnormal gas exchange yet normal spirometry, and whose time to first diagnoses may be protracted due to the reliance of spirometry measurement alone.

Methods

A retrospective review of all patients attending the lung function laboratory from July 1995 - July 2018 was undertaken. Spirometry and Single Breath Gas Transfer were performed to ERS/ATS standards, with +/-1.64 standardised residual FEV1%VC Max used to identify normal spirometry and <-1.64 standardised residual used to identify abnormal TLCOc.

Results

Of 41,480 visits, 5759 (13.9%) were identified on first presentation as having normal Spirometry, yet abnormal gas transfer, once corrected for Hb.

Within the cohort of 5759 patients, 3270 were female and 2489 male, with a median (IQR) age of 63 (24) years. TLCOc median (IQR) standardised residual -2.23 (0.86). FEV1%VC Max median (IQR) standardised residual -0.25 (1.4).

Conclusions

We have demonstrated that a large proportion of patients referred to secondary care with symptoms suggestive of respiratory disease have normal spirometry, yet abnormal gas transfer. These results have implications when solely utilising spirometry in order to detect respiratory disease earlier and will ultimately result in a continued protraction of patient diagnosis.

References

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P11

P11 - Is overnight pulsed oximetry a suitable diagnostic test for sleep apnoea in the National Health Service?

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Background: University Hospitals Plymouth National Health Service Trust (UPHNT) perform overnight pulsed oximetry in patients suspected with SA. If the test result is inconclusive then further investigation by multi-channel sleep study is carried out to confirm diagnosis. This is not recommended by the American Academy of Sleep Medicine.
Methods: Ethical approval was obtained from UPHNT and University of Plymouth before data collection. Retrospective data analysis of 68 patients within the trust who were being investigated for SA between January 2017 and January 2019. Patients performed overnight pulsed oximetry followed by a multi-channel sleep study. Test results were assessed for data quality before being statistically analysed. A paired t-test and a Bland-Altman plot were used to determine whether the oxygen-desaturation index (ODI) from overnight pulsed oximetry was in agreement with the apnoea-hypopnoea index (AHI) from multi-channel sleep studies. A Chi-square test for independence was used to determine association between the method of testing and SA severity classification.

Results: ODI determined by overnight pulsed oximetry consistently underestimated AHI determined by multi-channel sleep study. There were significant differences and poor clinical agreement between diagnostic results from the two methods of testing. 30.88% of patients with SA were misclassified as normal by overnight pulsed oximetry.

Severity classification	Number of participants (when measured by overnight pulsed oximetry)	Number of participants (when measured by multi-channel sleep study)
Normal	34 (50%)	13 (19.12%)
Mild	27 (39.71%)	26 (38.34%)
Moderate	4 (5.88%)	21 (30.88%)
Severe	3 (4.41%)	8 (11.76%)

P12

P12 - The OSA Pathway: Making changes to improve patient flow.

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Physiological services around the country are all facing increasing numbers with decreasing resources resulting in a need to streamline services whilst maintaining patient care and standards.
As a result, the Trust OSA pathway has changed so that patients no longer have to wait to see a doctor to get the results of their diagnostics investigations. Instead, the results and histories are triaged by a sleep specialist and a decision on care made; initiate CPAP, further testing, consultant review or discharge.
A retrospective analysis of 101 patients undergoing limited sleep studies for OSA was performed to determine whether this initiative would significantly reduce patient waiting times and improve patient care. Patients were grouped depending on whether they had their results triaged or had to wait until their consultant review.

	All	Appointments	Triaged	p-value Appointment vs Triaged
Number	101	36	65	
Days from diagnostic to report being ready	17.9	20.1	16.7	0.23
Days from diagnostic to decision being made	35	43.8	30.8	<0.05
Days from report being ready to decision being made	18.5	38.5	7.5	<0.001
Days from diagnostic to CPAP initiation	69.8	83.8	60.8	<0.05
Days from report being ready to CPAP initiation	53.9	66.8	45.7	<0.005

A significant difference in waiting times across all measured time frames was demonstrated with the exception of days between diagnostic being performed and being made available for review; report ready to decision – 31 days and time from diagnostic to CPAP initiation – 23 days. Of those who were triaged, 48% went straight to CPAP, 20% discharged, 6% sent for further testing and 22% to have an appointment to discuss the results. This was compared to those who had an appointment where 44% had CPAP, 39% discharged and 11% further testing.
The changes in pathway to allow for results to be triaged using patient reported history and diagnostic results significantly reduces the patients' waiting times when referred to secondary care for possible OSA. The greatest difference was seen in the time between a diagnostic report being made available and a decision being made. This offers a number of benefits to the patient by not only reducing their wait time but allowing recognition of urgent cases which can then be expedited. This also reduces stress on the service caused by changing appointment dates that the results are required for and leads to advanced roles by physiology staff in taking appropriate histories and delivering diagnoses.

P13

P13 - Successful use of adaptive servo ventilator to treat opioid induced central sleep apnoea

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Successful use of adaptive servo ventilator to treat opioid induced central sleep apnoea

51 year old presented to the sleep apnoea clinic with classic symptoms of obstructive sleep apnoea (OSA). He had been referred by his GP for excessive daytime sleepiness, Epworth sleepiness score (ESS) 19/24, he was overweight with a BMI of 29. Overnight pulse oximetry showed cyclical desaturations with an ODI of 40 and mean saturations 93%.

He had history of addiction to Oxycodone and had been on a weaning regime of Methadone which he was currently taking 105mg daily.

CPAP treatment was commenced in December 2016 with remote monitoring enabled. It soon became apparent that CPAP was not benefitting the patient symptomatically. The AHI derived from the device's algorithm was showing an obstructive index of 7 and central index of 28. Methadone use was the most likely cause of the central events.

The patient continued with CPAP treatment for three months with good compliance averaging 5.5 hours/night and continued to wean the Methadone. ESS remained high and the patient was dozing throughout the day.

It was decided at sleep MDT that he would be a good candidate for an adaptive servo-ventilator (ASV) device.

Within one month of swapping from CPAP to ASV he had noticed massive symptomatic benefit, now scoring zero on the ESS.

The patient continued using the ASV device and attended for annual follow up whilst continuing to wean the methadone.

July 2019 the patient contacted the sleep team informing us that he had completely weaned off the methadone and would like to be retested.

A limited sleep study was performed which showed the central sleep apnoea to have completely resolved. AHI 8.9, ODI 9.8, central index 0.8, obstructive index 0.2 and hypopnea index 8.3.

Patient is now trialling a month with no treatment at all to see how he feels.

Learning Points

Pulse oximetry as first line test missed the central aspect. The department is swiftly moving towards using 5 channel sleep recorders as first line of testing.

All patients with an element of central sleep apnoea trial CPAP for 3 months to see if any symptomatic benefit, so treatment wouldn't have differed if centrals were picked up initially.

Relied purely on CPAP device algorithm but to good effect.

The improvement in ODI alone highlights the improvement in results overtime.

P14

P14 - Audit of a Sleep Apnoea Service: CPAP Keepers versus Returners

TM Cunnington, K Hodge, JA Hunt, S Huq, S Madathil, C O'Sullivan, F Rauf, **Professor Brendan Cooper**[1], Dr James Stockley[1]
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Audit of a Sleep Apnoea Service: CPAP Keepers versus Returners

Introduction
Given the pressures on our sleep apnoea service we performed an audit of new patients suspected of having OSAHS over a 3 month period and reviewed the difference of those who remained compliant (>4hours/night at 3 months) with CPAP and those who gave up the therapy (Returners)

Methods
Data on referrals for OSA over the 3 month period (July- October 2018) using either home oximetry (n=57) Embletta polygraphy (n=38) or both (n=9) were reviewed along with Epworth Sleepiness Score (ESS), CPAP pressure (ResMed Autoset), time on CPAP. From 107 consecutive patients, complete data were available on 104 Compliant (Keeper) and Returner patients. Appropriate Student's t-tests or Wilcoxon signed rank tests used as appropriate for parametric and non-parametric analysis respectively.

Results
104 patients had an auto-titrating CPAP trial for 1 week. 57 (54.8%) were issued with CPAP, 23 (22.1%) had trial extensions and 24 (23.0%) returned their machines after 1 week. 29/57 (50.9%) were still on CPAP at 3 months. The results between Returners and Keepers are shown in the Table1;

Table 1	**CPAP Returners**	**CPAP Keepers**	**Significance**
Baseline ESS	12.7 (5.4)	11.6 (7.0)	NS
Baseline ODI/DI	34.6 (26.5)	34.5 (28.9)	NS
Previous CPAP trial	11/57 (19.3%)	12/24 **(50%)**	p<0.05
Mild/Moderate/Severe	**22**/16/21	5/13/15	(Mild only) p<0.05
No. Compliant at Night1	**63**	24	p<0.05
No. Compliant at Week1	47	57*	NS
No. Compliant at 3 Months	0	**33**	p<0.05
Extended trial after 1 week	**24**	6	p<0.05
Issued CPAP	**57**	33	p<0.05
Returned CPAP @ 1 week	**24**	0	p<0.05
Days used	7.36 (15.7)	**43.4** (59.7)	p<0.05
Failed to use CPAP on Night 1	5/57 (20.8%)	5/24 **(8%)**	p<0.05
CPAP Pressure (cm H2O) N1	13.3 (3.9)	10.2 (4.5)	NS
CPAP Compliance (mins) N1	**171** (112)	376 (145)	p<0.05
3/12 Compliance (Mild)		14.4 (9.5)	
3/12 Compliance (Moderate)		78.5 (37.2)	

3/12 Compliance (Severe)		69.4 (33.7)	

Mean and standard deviation (SD) Compliers vs Returners: significances = NS
*Patients persuaded to do 1 week trial after failing Night 1.

Conclusions

There were no difference in the baseline characteristics of the CPAP returners and keepers in terms of ESS or mean DI although there were more mild OSA patients in the returners group. Keepers were more likely to have already had a previous CPAP trial.

It was not possible to predict returners from their CPAP compliance or mean pressure on Night 1 or Week 1, but their duration of CPAP use was less on Night 1. Patients who fail to use CPAP on Night 1 ultimately tended to return the device. We confirm that CPAP compliance in mild OSA is poor and CPAP should not be attempted to save resources.

We are considering simplifying our sleep apnoea pathway to a single diagnostic sleep study followed by a single night of CPAP assessment before deciding to issue CPAP long term. We anticipate reducing the number of patient: physiologist interactions dramatically from our current model and therefore increase our capacity to diagnose and treat OSAHS.

P15

P15 - Audit of a Sleep Apnoea Service: How long should a CPAP Trial last?

TM Cunnington,, K Hodge, JA Hunt, S Huq, S Madathil, C O'Sullivan,, F Rauf, James Stockley, **Professor Brendan Cooper[1]**
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Audit of a Sleep Apnoea Service: How long should a CPAP Trial last?

Introduction
We performed an audit of our routine sleep apnoea service to compare whether 1 night, 1 week or 2 week trials of CPAP assessment produced different answers.

Methods
Data on routine consecutive referrals for OSA over the 3 month period (July- October 2018) using either home oximetry (n=57) Embletta polygraphy (n=38) or both (n=9) were reviewed along with Epworth Sleepiness Score (ESS), From 104 patients, complete DI, CPAP pressure using ResMed Autoset, and ESS data were available on 70 patients. Oximetry on CPAP was measured using oximetry and the AHI on Night 1 was taken from the CPAP itself. Student's t-tests or Wilcoxon signed rank tests were used as appropriate for parametric and non-parametric analysis respectively. Patients received an auto-titration CPAP assessment for 1 or 2 weeks and we analysed their compliance on nights1, 7 and/or 14 respectively.

Results
1 patient (1.4%) was classified as normal, 14 (20.0%) had mild, 23 (32.9%) had moderate, and 32 (45.7%) had severe OSAHS. Baseline ESS (mean (SD) was 12.8 (5.3) and by the end of all trials dropped to 8.8 (6.0), NS.
The results are for ODI/DI are shown in the Table1 and show that there were no differences in the ODI/DI on night 1, week 1 or week 2.

Table 1 ODI/DI	**Baseline**	**Night 1**	**Week 1**	**Week 2**	**Week 1or 2**
Mean	39.1	4.7	4.0	4.3	4.0
Median	26.7	3.1	2.5	2.6	2.5
SD	31.4	4.6	4.3	5.9	4.7

Mean, median and standard deviation (SD). Significances = NS for all CPAP nights.

The mean CPAP pressure (cm H_20) was the same on Night 1 [Mean (SD)13.8 (4.0)] and either at Week 1 or 2 [13.6 (3.8)]. The difference in CPAP pressures (cm H2O) for 1 night, 1 week, 2 weeks or 1 or 2 weeks were between <2.0 in 47 patients, 2-3 in 10 patients, 3-5 in 6 patients and >6 in only 2 patients. Pressure differences between 1 night and 1 or 2 week assessments only differed by <3 cm H_2O in 57/65 (87.6%) of patients.

Conclusions
1. The ODI/DI on night 1, week 1 or week 2 can all be used to demonstrate that CPAP is effective. Therefore CPAP trials on 1 night are overall as useful as 1 and/or 2 week trials.
1. The therapeutic CPAP pressure can be determined after a single night assessment in most patients.

2. We believe that CPAP assessments can be shortened to a single night and that multiple nights are rarely beneficial in improving the CPAP pressure requirement.

P17

P17 - A clinical quality improvement project on adherence to Continuous Positive Airways Pressure (CPAP) in mild obstructive sleep apnoea (OSA)

Miss Shirley Coelho[1], Mr Alain Al-Helou[1], Mrs Yasmin Khan[1], Mr Simon Wharton[1], Mr Rahul Mukherjee[1]
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Title	**A clinical quality improvement project on adherence to Continuous Positive Airways Pressure (CPAP) in mild obstructive sleep apnoea (OSA)**
	Introduction: Benefits of CPAP in treating OSA are well-established. Several determinants of adherence to CPAP have been studied, including the apnoea-hypopnoea index at diagnosis (AHI), daytime sleepiness, facial anatomy and mask fit. However, study results have been inconsistent. Our own audit from our first Plan-Do-Study-Act (PDSA) cycle proved AHI to be a strong predictor[1] although due to limited follow-up arrangements prior to the advent of telemonitoring, the adherence in mild OSA patients given a trial of CPAP due to excessive daytime sleepiness characterised by an Epworth Sleepiness Score (ESS) >10 with AHI>10 or for troublesome snoring with unrefreshing sleep was not known. **Methods:** We closed the audit loop of CPAP adherence (>4hours usage per night) of mild OSA patients that were given a trial of CPAP between 01 April and 31 May 2018, using telemonitoring. **Results:** Out of a total of 43 patients confirmed to have mild OSA in the two months, 24 (56%) were offered a trial of CPAP – 2 declined and 4 had no data due to not being on telemonitoring. Out of the 18 patients with telemonitoring data, 8 (44%) were adherent at 30 days and 90 days. None of those who were non-adherent at 30 days were adherent at 90 days. **Conclusion:** In mild OSA patients given a trial of CPAP for ESS >10 with AHI>10 or for troublesome snoring with unrefreshing sleep, at least a third are adherent to treatment. In keeping with our first PDSA cycle findings, AHI as a disease factor remains a strong determinant of CPAP adherence and as surmised, telemonitoring is giving better insight into CPAP management. Further studies are needed to ascertain (a) patient factors behind CPAP adherence and (b) feasibility of improving the cost-effectiveness of CPAP therapy by withdrawing CPAP machines from definitely non-adherent patients and reusing them to rationalise resource use. **References**: Mukherjee D, Shilliday N, Chakraborty B, Daniels M, Mukherjee R. Clinical Audit of Adherence to Continuous Positive Airways Pressure (CPAP) in Obstructive Sleep Apnoea (OSA). *Respirology* 2017; 22:3, 88–278. (doi: 10.1111/resp.13207_165)

P18

P18 - Clinical Audit: Do we achieve the 28 day target for urgent referrals for suspected OSA in drivers?

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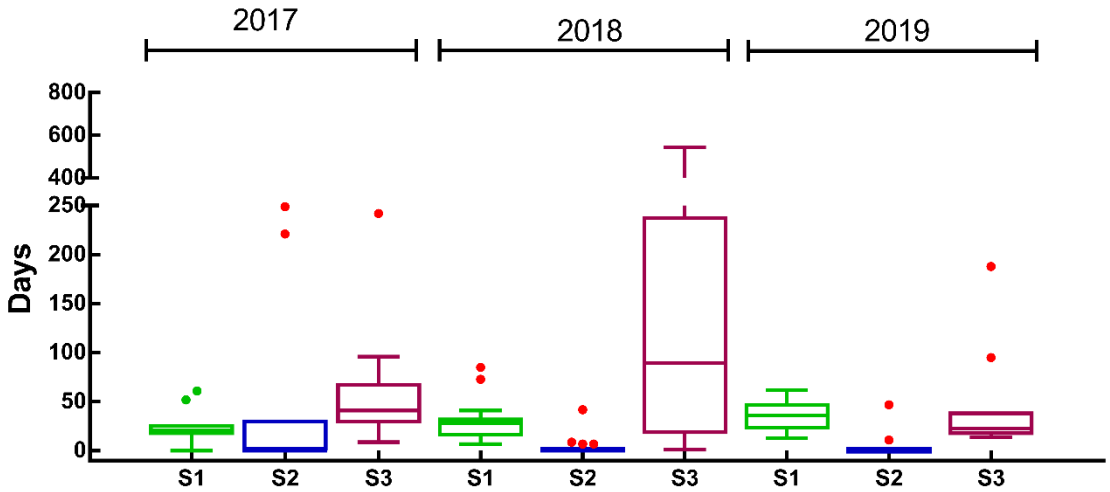
NICE (2015) and the Sleep Apnoea Trust Association recommend that occupations, such as HGV drivers, are urgently referred for sleep assessment and subsequent management within 28 working days from referral. Our pathway is Stage 1 (S1) - triage for 2 nights pulse oximetry to consultant review, Stage 2 (S2) - S1 to commencing CPAP and Stage 3 (S3) – S2 to consultant follow-up.
We undertook an audit of how this pathway is working in relation to new referrals to our service, determining the time periods for each stage (S1, S2 and S3) of the pathway. Data on all urgent patients was collated from 2017 to 2019. The time points at each stage was determined in calendar days. Patients from each year were randomly selected and the data analysed.
46 patients were reviewed – 11 in 2017, 24 in 2018 and 11 in 2019. The median and range were obtained at each stage of the pathway and the results summarized in the figure. The median time for each year for S1 was 21, 28 and 36 days, for S2 was 0 for all three years and for S3 was 41, 89.5 and 23 days. For each year the median total time 62, 117.5 and 59 days. Over the 3 years, the median time for completion was 81 days (IQR of 51 to 254 days), and the range bring 16 days to 640 days. Explanations for the extremes included requiring further investigations – limited polysomnography, patient and hospital appointment cancellations or being lost to follow-up. Only 12.7% of patient were completed within 28 days.
This audit demonstrates that we failed to meet the 28 day target in more than 80% of referrals for urgent pathway patients. The one positive was the ability to undertake a CPAP trial on the same day as the consultant review in most patients.
In the light of this audit we have completely remodelled our pathway to ensure that patients triaged as urgent are clearly identified and are prioritised through our system to achieve the 28 day target. We will re-audit in late 2020.

Figure. Median and IQR with outliers shown for each stage of the sleep pathway in those patients triaged as urgent across three consecutive years.



P19

P19 - Comparison of WatchPat to limited polysomnography studies in adults with suspected sleep-breathing disorders.

Dr Adrian H Kendrick[1], **Mr Alain Fildes[1]**
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With the increasing drive to undertake more complex studies than simple pulse oximetry, there is a need for systems that can be easily used by patients whilst providing more information than just pulse and SpO_2. WatchPAT is a portable diagnostic device for studies of suspected Obstructive Sleep Apnoea (OSA) in adults. It is worn as a wrist pulse oximeter, but uses Peripheral Arterial Tone (PAT) to undertake complex signal analysis, thereby providing detailed information on sympathetic nervous system changes associated with Sleep Disordered Breathing (SDB) events and specific "signatures" of sleep stages.
This study had internal Trust approval and patients verbally consented to use the WatchPat device. All patients were admitted on clinical grounds for overnight sleep studies using limited (no EEG) polysomnography. Simultaneous recordings were obtained from WatchPat and SOMNOscreen PSG (S-Med, UK). Studies were scored for SpO_2 mean, SpO_2 >4%, SpO_2 time <90% and AHI and compared using Bland-Altman analysis. Data are given mean ± SD.
39 studies were completed. The results are summarized in the table. For AHI, 25/39 (64%) of the studies were correctly classified by WatchPat as positive (mild/mod/severe) compared to SOMNO, giving a sensitivity of 75% and specificity of 80%. Of the studies that were mild (SOMNO), 10/17 (59%) were correctly identified, with 4/17 classified as normal and 3/17 as mod/severe.
This study has demonstrated that there is clinically acceptable differences between an in-lab study and WatchPAT for SpO_2 and AHI and therefore WatchPat could be used as an acceptable screening tool for suspected OSA. The one advantage that WatchPat provides over simple pulse oximetry is the indication of sleep versus wake and the indicated presence of REM sleep. By knowing when the patient is asleep, greater accuracy can be obtained in defining the AHI for when the patient is asleep.

Table: Summary of data comparing WatchPat to the in-lab SomnoMedics device. Data for SpO2 and AHI are from n = 39. Data are given as mean ± SD. For Bland-Altman, data is mean difference between devices ± bias of x1 SD.

Index	WatchPat	SOMNO	Bland-Altman
SpO_2 mean (%)	95.23 ± 1.06	94.4 ± 1.31	0.87 ± 1.0
SpO_2 > 4%	4.65 ± 9.34	5.5 ± 10.1	-0.85 ± 3.05
AHI (events/hr)	9.7 ± 11.9	9.6 ± 11.6	0.20 ± 7.3

P20

P20 - BTS Standards of Care for Occupational Asthma

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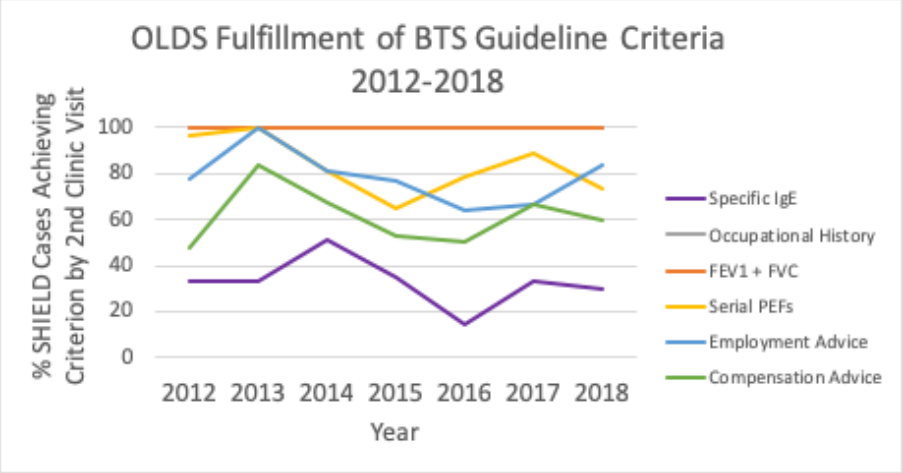
BTS Standards of Care for Occupational Asthma

Occupational asthma (OA) is variable airways obstruction caused by exposure to an inhaled agent in the workplace. Swift detection and management of OA improves prognosis. The BTS Standards of Care for Occupational Asthma (2008) recommends that all patients with suspected OA should receive a full occupational history, spirometry for FEV1/FVC, serial PEFs, specific IgE bloods, employment advice and compensation advice by their second outpatient appointment. We compared the Birmingham Occupational Lung Disease Service's (OLDS) adherence to the BTS Standards of Care for OA to highlight areas of the service requiring improvement. The Midlands Thoracic Society surveillance scheme database of all Regional OA patients (known as Shield), was utilised to identify all workers notified with OA between 2012 and 2018 (n=146).

Results; A comprehensive occupational history and spirometry were carried out in all patients. The completion of serial PEF recording and Oasys analysis (the principal method of objective confirmation of occupational asthma) dipped to 63% in 2015, exacerbated by referral after removal from employment. Provision of compensation and employment advice was lower at the time of notification, as employment advice requires the identification of the cause of occupational asthma, which often took longer. Specific IgE measurement was the lowest as not generally available for most agents. The OLDS performed the best in 2013, with 86% fulfilment of the guidelines. There was a subsequent steady decline to 67% in 2016 when the service was without a lead. Since appointment of a service lead, performance has improved (See Figure).

Recommendations for service improvement include the production of an instructional video for ideal PEF technique, text reminders for patients to record PEF data, and investment into smartphone-compatible digital PEF meters for easy recording and sharing of data. Computer alerts for clinicians reminding them to complete and record fulfilment of BTS criteria as well as the production of local standards of care may improve service provision for the future.



P22

P22 - The effects of single breath gas transfer measurements on carboxyhemoglobin levels over the period of a working day.

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The effects of single breath gas transfer measurements on carboxyhaemoglobin levels over the period of a working day

Category A

Background: There is minimal research on the effects of high-intensity short time exposure of carbon monoxide. The impact of performing single breath gas transfer as part of the biological control process on carboxyhaemoglobin (COHb) levels throughout the day should first be studied to enable justification of researching the potential long-term effects it can have on the participant.

Methods: Using a Micro+ Smokerlyser (Bedfont Scientific Limited, 2009), parts per million (ppm) of exhaled carbon monoxide was measured and an estimation of COHb in percent provided. Four male, and one female physiologist mean (SD) age 28±9.8 years took part in the study. COHb was measured at baseline and immediately post two standard single breath gas transfer procedures with four minute intervals between. Further COHb measurements were made every 30 minutes for the first 2 hours, followed by every hour from 2-7hours.

Results:

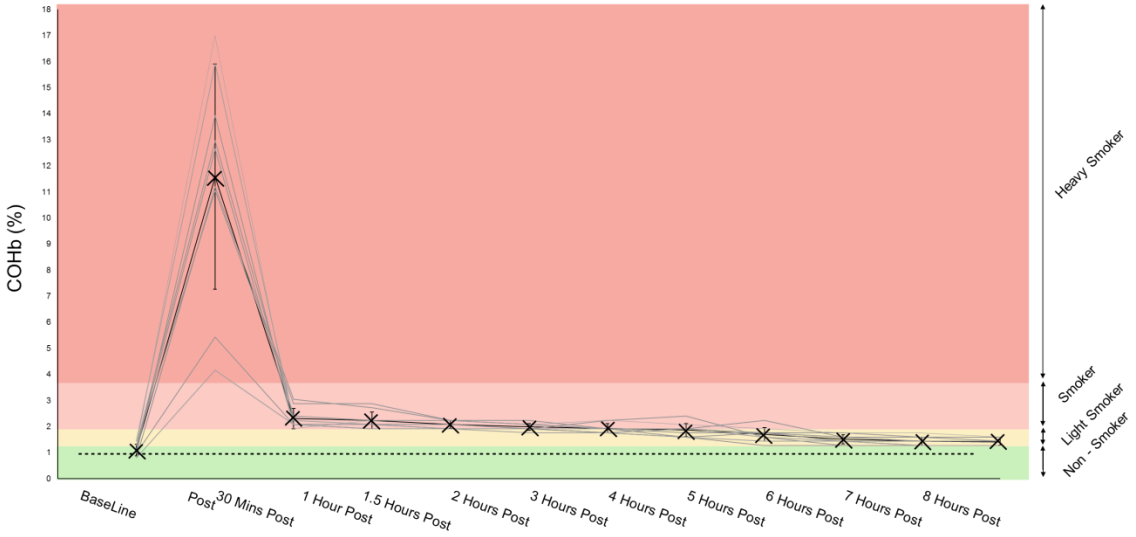

Figure 1: Solid black line indicates the mean data for all participants and grey lines demonstrate individuals data. Changes in COHb levels immediately post gas transfer measurement are demonstrated, followed by a rapid decline in COHb during the first half hour post gas transfer. Base line results showing mean(SD) 1.08±0.22 COHb%, 11.57±4.32 COHb % directly post and 1.39±0.12 COHb% 8 hours post gas transfer testing.

Conclusions: There are considerably raised COHb levels post single breath gas transfer measurements at levels similar to the World Health Organization (2010) carbon monoxide limits. Levels remain within the light smoker range at least 7 hours post procedure. Further research is warranted into the potential long

term health effects of participants partaking in biological quality control procedures that incorporate single breath gas transfer measurements on a high frequency basis. The latest ATS/ERS (2017) recommendations for the validation of gas transfer suggest biological quality controls be performed weekly. This can be from a healthy participant or mechanical syringe. The long term effects of biological quality control of gas transfer have yet to be studied but with this research and latest recommendations, it may encourage and inform departments to look into other methods of validation.

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P23

P23 - Are we using the right parameters to grade a restrictive ventilatory defect?

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Are we using the right parameters to grade a restrictive ventilatory defect?

Introduction
The ATS/ERS guidelines (2005) define a restrictive ventilatory defect as a reduction in total lung capacity (TLC) below the 5th percentile of the predicted value with a normal FEV/VC ratio. The gold standard of diagnosis involves measuring TLC through static lung volume (SLV) testing.
Historically static lung volumes have been used to confirm a diagnosis of pulmonary restriction however with recent advances through drug trials, medication and increasing demands on services, the primary focus has concentrated on monitoring changes in ventilatory capacity (VC).

Aim
To evaluate the importance of TLC measurement in monitoring a restrictive ventilatory defect as opposed to measuring VC alone.

Method
An audit was carried out within the respiratory physiology service at the Royal Infirmary of Edinburgh within a four month period to investigate how a potential diagnosis would differ if patients attended solely for spirometry and transfer factor rather than full pulmonary function tests (spirometry, transfer factor and lung volumes – He dilution) as part of their routine review. The patient group focused mainly on those who had referral querying a restrictive ventilatory defect for example, pulmonary fibrosis, asbestosis, interstitial lung disease.

Results

Conclusion
73/89 patients had normal spirometry so without lung volume measurement a likely diagnosis of true restriction would not have been made, potentially resulting in misdiagnosis and limiting access to treatment options.

Reference
ATS/ERS task force: Standardisation of lung function testing. Interpretative strategies for lung function tests. Eur Respir J 2005;26:948-968

P24

P24 - Pre-operative Spirometry Identifies Undiagnosed Lung Disease in Cardiac Patients

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Pre-operative Spirometry Identifies Undiagnosed Lung Disease in Cardiac Patients

Background

In the UK around 1.2million people have a formal diagnosis of COPD, however, over 2 million more may be undiagnosed. Shared risk factors and symptoms exist for cardiovascular disease and COPD. Many cardiac surgery candidates undergo spirometry for pre-operative assessment; this may represent a potential case-finding opportunity. We aimed to assess the utility of pre-operative spirometry to identify undiagnosed lung disease in patients listed for cardiac surgery.

Methods

100 consecutive patients performed pre-cardiac surgery spirometry according to ATS/ERS guidelines. Obstruction was defined as FEV_1/FVC <0.7. Reversibility was not performed and no distinction between COPD, asthma, and lung diseases was made after testing. A detailed search of patient's hospital electronic patient record system was performed after patient discharge.

Results

Of the 100 patients undergoing cardiac surgery a total of 43 patients (43%) had airflow obstruction, 42 (42%) were normal, and 15 (15%) were restrictive.

Of the obstructive patients 14 (33%) were mild, 25 (58%) moderate, and 4 (9%) were severe. Pre-existing lung disease or abnormality was documented in 18 (42%) obstructive patients. COPD was reported in 12 (67%), asthma in 4 (22%), bronchiectasis in 1 and 'obstructive lung function' in 1. Medications prescribed for lung conditions were documented for 14 (33%) patients. Reference to spirometry was shared with a GP in 13 (30%) patients. Of the 13 incidences where some spirometry information was shared, all main spirometric indices (FEV_1, FVC, FEV_1/FVC ratio) or an interpretation of spirometry were only provided on 1 occasion.

Conclusion

A high proportion of patients undergoing cardiac surgery had airflow obstruction, many with no prior diagnosis of respiratory disease. Spirometric findings were poorly disseminated resulting in under-diagnosis in those without established respiratory disease or potential test duplication. The routine sharing of pre-operative spirometry may reduce missed cases of disease and reduce test duplication. Furthermore, the opportunity to optimise previously undiagnosed lung disease to improve surgical outcomes warrants further investigation.

P25

P25 - Modified CO uptake and elimination model compared with pulmonary function observations

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Introduction: Carbon monoxide (CO) poisoning is an important public health issue globally. Mathematical models for predicting the uptake, distribution, and elimination of CO could help assess exposure scenarios. The best-known models are the Coburn-Foster-Kane (CFK) equation and the Bruce and Bruce multi-compartment model. Both
produce acceptable predictions when compared with observations. However, several additional factors could improve the model, such as including variations with height, age, smoking, lung function and disease status. Purpose: We aim to investigate a simplified version of the compartment model for CO by comparing its predictions against observed data. Method: As CO is routinely used to estimate lung function, observed data gathered from lung function testing can be used to estimate variations in
model predictions. We collected 3,512 patients' data from June 2017 to May 2018 from Tri-Service General Hospital (TSGH) in Taipei. After excluding the data not fulfilled the study criteria, there were 419 patients analysed demographic variables and
CO diffusion capacity (DLCO) from TSGH. This study has obtained the ethics committee approval from TSGH and UCL. Results: The predicted model for DLCO(TLCO): Women= -3.856-
0.119*age(yr)+0.133*height(cm)+0.125*weight(kg);
Men=-1.321-0.210*age(yr)+0.165*height(cm)+0.102*weight(kg). Then, the researchers used the model from Gosselin et al. to predict the effects of different variables (see Figure 1). We calculated the DLCO and VA from the predicted model in
the study by assuming man (case a1): 20 yrs, 180 cm and 75 kg; woman (case b1): 20 yrs, 160 cm and 50 kg. The DLCO were 31.829 ml/mmHg/min (TLCO: 10.656 mmol/min/kPa) for man and 21.294 ml/mmHg/min (TLCO: 7.129 mmol/min/kPa) for woman. After reviewing against the lung function data, the researchers modified the values of DLCO to 40 ml/mmHg/min (TLCO: 13.392 mmol/min/kPa) for man (case a2) and woman (case b2) to see the influence of the change.

P26

P26

P26 - Audit of inaccurate referrals for lung function testing

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Title
Audit of inaccurate referrals for lung function testing
Background
As part of Improved Quality in Physiological Services (IQIPS) accreditation, we developed monthly drives in order to tackle specific tasks. One of these was based around identifying inaccurate requests that may not answer the clinical question posed and lead to unnecessary visits.
Aim
To assess the frequency, reason and source of inaccurate lung function referrals.
Method
Throughout the month of July 2019, all lung function referrals made to Heartlands Hospital were scrutinised by one member of staff. For each request we collected data on: in or out patient request, requesting individual, consultant's authority, the speciality, reason for testing, tests requested and the corrections made. A referral was deemed inaccurate if 1) a bronchial reactivity test was requested and no treatment form completed; 2) there was no clinical information or 3) the wrong tests were requested based on the clinical question.
Results
In July 2019, our department received 206 requests for lung function. Respiratory is the main referrer with 72% (147) of referrals, followed by haematology with 10% (21). 25% (52) were deemed inaccurate; 67% (35) of which were due lack of treatment form, 12% (6) due to lack of clinical information, 17% (9) due to wrong tests requested and 4% (2) due to "other" reasons. The charts below represent the inaccuracies per speciality.

Graph 1 - % of inaccurate requests per specialty. The number of inaccurate requests is against the total referrals made by specialities.

Conclusion
We were expecting a higher number of inaccurate referrals; this might be due to the time frame chosen to collect data. The main issue of non-completion of the treatment request form should be solved once the requests and prescription can be done electronically. The number of "wrong tests" requested could be due to changes in guidance or limited knowledge of what tests are needed for specific procedures. We were expecting more requests from Rheumatology, given the tight link between rheumatologic conditions and treatments and lung damage.

P27

P27 - Cardiopulmonary response to stair climbing in patients with dysfunctional breathing: an exaggerated fight or flight response?

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Cardiopulmonary response to stair climbing in patients with dysfunctional breathing: an exaggerated fight or flight response?

Background: Dysfunctional breathing (DB) is recognized to be a prevalent cause of unexplained exertional dyspnoea[1]. Anecdotally, many patients with DB report breathing difficulty on commencing stair walking. A disordered ventilatory response has previously been proven in DB during cardiopulmonary exercise testing (CPET) in a laboratory setting[2]. The aim of this work was to now evaluate the ventilatory response to a real-life stair climb protocol, in patients with DB and compared with a matched control group.

Methods: A prospective cohort study of adults with DB were recruited from our unexplained breathlessness service. Participants were required to complete dyspnoea-related questionnaires (Dyspnoea-12 and a Nijmegen), spirometry and a stair-climb challenge (4 flights) with portable CPET equipment in situ. Dyspnoea on the BORG scale (0-10) was measured at rest and on stair climb cessation. Age, gender and BMI matched controls were recruited to undergo similar assessment. Data were analysed using Mann-Whitney U test comparing controls and DB subjects and P-values of < 0.05 were considered significant.

Results: We assessed 11 subjects with DB and 13 controls, well matched for gender and age (Table). Patients exhibited higher questionnaire scores and had evidence of an amplified ventilatory response to the stair challenge. Specifically, peak values and change in ventilation and breathing frequency was greater in patients, despite normal resting lung function and a similar peak oxygen uptake and heart rate response.

Conclusion: Patients with DB demonstrate an exaggerated ventilatory response to stair climbing. Specifically, perception of dyspnoea and change in ventilation is greater despite a matched cardiac response, when compared with a control group. This finding aligns with patient's self report and provides insight regarding the control of ventilation to real-life activity in DB. Further work is now needed to explore underlying mechanisms for this disordered physiologic response.

1. Boulding R, et al. *Eur Respir Rev*. 2016;25(141):287-294. doi:10.1183/16000617.0088-2015
2. Bansal T, et al. *Respir Physiol Neurobiol*. 2018;255:1-6. doi:10.1016/j.resp.2018.05.002

Table

	Control (N = 13)	Patient (N = 11)	p value	
Gender: M:F	3:10	5:6		
Age	49 (8.0)	54 (9.9)	0.19	
BMI	25.8 (5.2)	28.7 (2.9)	0.05	*
FEV1% predicted	99 (15.8)	109 (10.3)	0.23	
FVC% predicted	101 (17.8)	115 (12.3)	0.04	*
FEV1/FVC Ratio	0.82 (0.0)	0.78 (0.1)	0.04	*
Nijmegen	3.5 (4.7)	23.1 (9.8)	0.00	**
Dyspnoea-12	0.0 (0)	15.7 (8.6)	0.00	**
REST MEASUREMENTS:				
VE rest (L/min)	11 (4.1)	12 (4.9)	0.36	
BF rest (1/min)	17 (3.3)	22 (5.0)	0.01	*
VO_2 rest (ml/min/kg)	4.5 (1.2)	3.8 (0.7)	0.11	
HR rest (1/min)	78 (14.3)	78 (9.5)	0.73	
Borg Rest	0.1 (0.3)	0.6 (0.8)	0.06	
PEAK MEASUREMENTS:				
VE peak (L/min)	24 (8.6)	36 (9.0)	0.01	**
VE % of Max (%)	22 (0.1)	31 (0.1)	0.02	*
BF peak (1/min)	21 (4.1)	31 (11.0)	0.00	**
VO_2 peak (ml/min/kg)	13.2 (2.6)	14.1 (3.0)	0.57	
HR peak (1/min)	121 (18.9)	116 (16.8)	0.65	
Borg Peak	0.8 (0.8)	4.3 (1.6)	0.00	**
CHANGE FROM REST TO PEAK:				
ΔVE (L/min)	13 (6.7)	23.6 (5.4)	0.00	**
VE change (%)	125 (73.7)	206 (52.3)	0.01	**
ΔBF (1/min)	4 (4.2)	10 (8.6)	0.21	
BF change (%)	27 (29.4)	45 (39.7)	0.42	
VO_2/kg % change	209 (114.0)	275 (74.5)	0.04	*
ΔVO_2 (ml/min/kg)	8.6 (2.8)	10.3 (2.7)	0.23	
ΔHR (1/min)	43 (14.8)	38 (16.5)	0.61	
ΔBorg	0.8 (0.6)	3.7 (1.6)	0.00	**

Numbers are mean (SD) unless otherwise stated. **M:F**: Male:Female; **BMI:** body mass index; **FEV1:** forced expiratory volume in the first second; **FVC;** forced vital capacity; **VE:** exhaled volume/ breath; **BF:** breathing frequency; **VO_2:** Oxygen consumption/min; **HR:** heart rate: **Δ:** delta, * $p < 0.05$, ** $p < 0.01$

P28

P28 - Estimation of the VO2/WR slope in relation to duration of a treadmill exercise test

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Work efficiency is a measure of the metabolic cost of performing external work. In incremental exercise this is usually expressed as the slope of the relationship of oxygen uptake to work rate (VO_2/WR). This slope has a normal range of 10.3 ± 1.0 $mL.min^{-1}$, or 8.3 to 12.3 at ± 2SD. We have observed that during incremental treadmill exercise, spuriously odd values are observed.
WR from the treadmill was estimated based on the speed, slope and weight of the subject. A modified Balke protocol was used with speed adjusted to the capability of the subject with 3% increments every minute. VO_2 was directly measured via a facemask. All data was presented within an integrated CPET system (LoveMedical, UK). Each slope was visually assessed to ensure accuracy.
Data on 99 patients were collated for the duration of exercise and the VO_2/WR slope. 41 were referred from the congenital heart group, 53 from Pre-Op and 5 from other sources. The median (IQR) duration of exercise was 7.1 (5.4 – 10.0) mins and VO_2/WR slope was 8.5 (6.0 – 11.2). There was a curvilinear relationship between VO_2/WR and duration of exercise (figure), with significantly high values observed during short period of incremental exercise and more stable values above 6 minutes of exercise. There was no obvious differences between the two groups.
The importance of an ideal minimum of 6 minutes of exercise is demonstrated in this study, where there appears to be insufficient time to accurately derive the VO_2/WR slope. Greater than 6 minutes appears to be have little effect on the accuracy of the estimation of the slope during treadmill exercise.

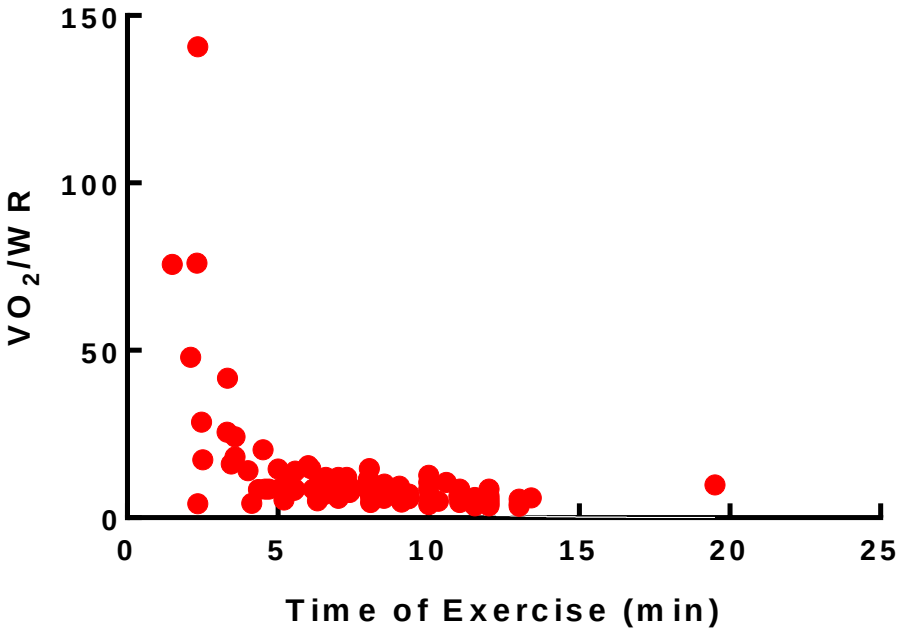

Figure. Relationship between VO_2/WR and time of exercise using a modified Balke protocol on a treadmill. The relationship is approximately described as $Y = 118.1^{e(-0.4135X)}$

P29

P29 - CARRYOVER EFFECTS OF SPIROMETRY AND BRONCHODILATOR ON MEASURED FENO VALUES IN CHILDREN

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CARRYOVER EFFECTS OF SPIROMETRY AND BRONCHODILATOR ON MEASURED FENO VALUES IN CHILDREN

Background/Intro: Guidelines recommend measurement of fractional exhaled nitric oxide (FeNO) before spirometry to avoid distortion of results by forced expiratory manoeuvres. Existing studies give conflicting results.

Objective: To assess the impact of spirometric procedures on FeNO in children

Methods: 20 patients aged 6-17 years underwent FeNO measurement using the 6 second exhalation modes at baseline, 1 minute post-spirometry and 15 mins post-subsequent bronchodilator (BD) administration (400mcg of salbutamol delivered via MDI and spacer). Patient characteristics were (Mean±SD); Age 12.2±3 years, Height 151±17cm, Weight, 55±26kg, FEV1% of predicted 93±16%, and FVC% of predicted 103±12%.

Results: ATS/ERS guidelines stipulate 10% FeNO reproducibility for valid a test. In this series, FeNO values were: Baseline – 36 ± 23 ppb, post-Spirometry – 33 ± 20 ppb and post-BD – 36 ± 22 ppb. The percentage differences in FeNO values at each time point were: baseline and post-spirometry - 8.4%, baseline and post-BD - 1.8% and post-spirometry and post-BD – 6.7%. There were no significant differences between all three time points (p=.059, Repeated Measures ANOVA).

Conclusion: Mean FeNO at all time points was within 10% as per recommendations. We found no evidence of an effect of forced spirometry or BD administration on FeNO in children. It may not be necessary to measure FeNO before spirometry.

P30

P30 - Tools for sleep apnoea management: a case report of post-APAP central apnoea

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Mr. AB, a 62 year-old man, was assessed at Norfolk and Norwich Hospital's Sleep Clinic. Mr. AB was referred for excessive daytime sleepiness and snoring, with a home cardio-respiratory sleep study showing an apnoea+hypopnoea index (AHI) of 36/hr with 90% obstructive events. Medications reported were inhaled therapy for COPD, an oral anti-psychotic and an anti-depressant. He was diagnosed with obstructive sleep apnoea syndrome and prescribed auto-adjusting positive airway pressure (APAP) therapy. His care pathway including periodic remote monitoring via device modem and specialist reporting of objective profiles of therapy in collaboration with Philips sleep support service.
Initially poor, unstable mask fit was detected and resolved in the first week, with APAP used thereafter on 98% nights for an average 9.7 hrs/night. During periodic APAP data reviews, residual AHI was mildly raised at 7-10 per hour, with 50% clear airway (central) apnoeas. Cheyne-Stokes respiration was not detected. Echocardiogram showed no cardiac abnormality. To assess further the residual sleep-disordered breathing (SDB), summary and daily detailed therapy graphs were inspected, as well as breath-by-breath flow waveforms.
Summary trend graphs showed semi-regular peaks in residual central apnoeas. Detailed hour-by-hour graphs from peak nights showed little snoring during central apnoeas, and associated waveforms showed qualitative pattern typical of Biot's (opiate) breathing (Figure).
A telephone consultation with patient confirmed that in addition to the previously noted medications, he is also prescribed a transdermal buprenorphine patch for chronic hip pain. We speculate that central apnoea peaks may be associated with replacement of the buprenorphine patch. This case shows the value of remote monitoring to not only detect and intervene promptly in early mask leaks, but also to assess type and frequency of residual respiratory events through data inspections at different levels of granularity.

P31

P31 - A review of cardiopulmonary sleep studies in Noonan syndrome

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Introduction

Noonan syndrome (NS) is a genetic disorder present in 1 in 2500 live births in the UK. It is characterised by facial deformities, short stature, cardiac defects and chest deformity. The additional presence of a small jaw and large adenoids may lead to obstructive sleep disordered breathing (oSDB) in children, but there are little data available on the incidence and prevalence of SDB or hypoventilation in children. We reviewed the cardiorespiratory sleep recordings performed on children with Noonan syndrome.

Methods

A retrospective review of cardiorespiratory sleep recordings performed on patients with Noonan syndrome (using Embla S4500 and Radiometer TOSCA500/TCM5) between Jun 2009 and Mar 2019. Studies were analysed according to AASM criteria.

Results

Over 10 years, we performed 34 studies on 14 patients; 6 patients had >1 study. Median age was 140 months (IQR=93-181), 8 male. Three patients had chronic lung disease, 3 had pulmonary hypertension and 2 associated Arnold Chiari malformation. Median total AHI (1.2 evs/hr) indicated mild sleep disordered breathing (oAHI=0.6, CnAHI=1.0) and normal transcutaneous CO2. One patient displayed severe obstructive sleep disordered breathing with hypoventilation. Two patients had received adenotonsillectomy, 1 patient had a tracheostomy in situ, 2 patients received non-invasive ventilation (NIV) and 5 used supplemental O2 during the studies.

Table 1 – sleep study data Parameter	Units	Median
Active Sleep	%	29
SpO2	%	95.2
SpO2 ODI	Dips/hr	4.5
SpO2 mean nadir %	%	92.4
TST SpO2<90 %	%	0.01
SpO2 nadir	%	90
AHI	Evs/hr	1.2
TcCO2	mmHg	39
TcCO2 max	mmHg	42

P32

P32 - Differences in height prediction between ulna length, arm span and standing height in paediatrics.

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Abstract

Background: Arm span, ulna length and standing height were measured in 30 patients aged 5 – 18 years who were not all free from physical deformities which can affect stature or arm span.

Introduction: Height measurement is important for assessment of children's growth, prediction and standardisation of physiological parameters including lung volumes, spirometry, transfer factor, muscle strength and according to World Health Organisation (1995), adjustment of drug dosage in patients. It is hard to measure body composition with accuracy due to influence by nutritional status and genetic factors.

Methods: The service evaluation was conducted by paediatric respiratory medicine department at Evelina London Children's Hospital, Westminster, London. Patients aged 5 to 18 years were recruited (with consent) for this study with asthmatic/neuromuscular condition. A paediatric respiratory physiologist collected the data for standing height, arm span and ulna length from all the patients. Results: Measurements were analysed using one-way repeated measures analysis of variance tests (SPSS 25.0). The findings of the current service evaluation show no significant different between standing height, arm span and ulna height ($p= 0.385$). Conclusions: No significant difference were found between the three measurements taken. Future studies could look to increase the number of patients

P33

P33 - Hypoxic Challenge Testing in Infants; who is recommended to fly with supplemental oxygen?

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Hypoxic Challenge Testing in Infants; who is recommended to fly with supplemental oxygen?

Background:

Infants with a history of neonatal chronic respiratory problems may demonstrate hypoxaemia when at in-flight oxygen levels, despite normal sea-level oxygen requirements. [1] BTS recommend these infants have hypoxic challenge testing (HCT) before air travel, SpO_2 <85% is recommended as a threshold below which in-flight oxygen is required and *"paediatrician discretion should be used when SpO_2 between 85-90% and, where there is doubt, the doctor should err on the side of caution."* [1]

Aims:

To establish how many infants fell into each of the threshold categories during HCT; SpO_2 <85%, >90%, 85-90% and which of these patients were recommended to fly +/- supplemental oxygen ($suppO_2$).

Methods:

Our HCT protocol for infants is 20 minutes in 15% FiO_2 within a body plethysmograph. SpO_2 is monitored throughout and $suppO_2$ administered via nasal cannula if SpO_2 < 85%. If at the end of 20 minutes SpO_2 has remained >85% but <90% then $suppO_2$ is titrated for 5 minutes to provide additional information. We reviewed data collected from infants (aged < 1 year) whom had HCT between March 2017 and August 2019.

Results:

Data collected from 58 infants, median age 27.6 weeks (range 5 to 51.6), 35 (60%) were male. None were receiving $suppO_2$ in room air prior to testing; all had baseline SpO_2 ≥96%. In 36 infants, SpO_2 did not dip to <90%. SpO_2 dropped to <85% in 13 infants, requiring administration of $suppO_2$. Nine infants required extended protocol due to SpO_2 at 85-90%. $SuppO_2$ corrected SpO_2 in all to baseline levels.

Of these 9 infants; 7 were ex-preterm, 1 recent thymus transplant, 1 pulmonary hypertension with congenital diaphragmatic hernia. 8/9 infants had a decision regarding flying post HCT. All 8 were advised by their clinician to use $suppO_2$ for air travel. The flight times in this subgroup ranged from 90 to 450 minutes. The remaining subject that had not received guidance for air travel is an international inpatient at the hospital with no discharge date set.

Conclusion:

Infants with baseline SpO_2 ≥96% may still exhibit SpO_2 desaturation during HCT. We found all paediatricians recommended in-flight oxygen for infants with HCT SpO_2 <90%. In the SpO_2=85-90% group, flight duration did not appear to affect the recommendation made.

1. Managing passengers with respiratory disease planning air travel: British Thoracic Society Recommendations Thorax September 2011.

P34

P34 - A comparison of sleep parameters measured by limited multichannel polysomnography and full polysomnography.

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Introduction
Inpatient full polysomnography (PSG) is the gold standard diagnostic to identify obstructive sleep apnoea syndrome (OSAS)[1]. Due to healthcare resources and utilisation many sleep centres employ limited multichannel sleep testing (MC) at the patient's home. Both diagnostic tests provide measurements of oxygen desaturation index (ODI), apnoea-hypopnoea index (AHI) and oxygen saturation (Sp02). The sleep studies however are subject to factors that may influence sleep quality, including environmental effects (location of performance and staff versus patient setup) that may influence overall sleep study scoring.

Methods
All patients referred to the CSU for investigation of OSAS who subsequently performed a PSG were included in this observational study. Patients who were symptomatic (Epworth score ?11) and received a diagnosis of mild OSAS (AHI 5-14/hr) continued to PSG. MC were performed using NOX T3 and PSG using NOX A1 (Nox Medical, Katrínartún, Iceland). Sleep scoring was in accordance with AASM guidelines version 2.3. Comparisons of data sets was performed using SPSS statistical software.

Results
Patient demographics are shown in Table 1. In total 8 patients were included. All patients scored a higher AHI on PSG compared to MC. Mean PSG AHI and ODI were significantly higher than MC (18.48/hr; 8.1/hr and 17.68/hr; 7.08/hr, p=<0.001 respectively). Sp02 was comparable between PSG and MC (92% and 94%, p=0.0135, respectively).

Discussion
Data from this single centre, small sample study shows higher AHI and ODI from PSG compared to MC in symptomatic mild OSAS patients. Reasons may include location of sleep and clinical support with sleep study setup. In this patient group it may be advised that PSG is required in order to confirm a diagnosis of OSAS and severity in order to select the most appropriate treatment modality and optimisation of treatment selections. Larger multicentre studies are required to substantiate the results from this study.

n=8	Mean (sd)
Sex (m)	6
Age (years)	38 (12)
BMI (kg/m^2)	32.1 (7.1)
Collar Size (inches)	16.6 (2.1)
Epworth Score	13 (2)
Sleep Latency (min)	18.2 (23.4)
PLMS Index	31.5 (38.7)
Sp02 T3 (%)	94 (2)
ODI T3 (/hr)	7.1 (3.6)
AHI T3 (/hr)	8.1(3)

Sp02 A1 (%)	92 (4)
ODI A1 (/hr)	17.7 (12.1)
AHI A1 (/hr)	18.4 (12)

Table 1. Patient demographics

P35

P35 - 129Xe ventilation MRI and LCI to assess acute maximal exercise as a method of airway clearance in cystic fibrosis

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^{129}Xe ventilation MRI and LCI to assess acute maximal exercise as a method of airway clearance in cystic fibrosis

Introduction: Exercise is increasingly utilised as a method for airway clearance in CF, yet the acute effects of exercise on regional lung ventilation are unknown. Hyperpolarised gas ventilation MRI (V-MRI) is highly sensitive to ventilation defects in CF, making it suitable for assessing the efficacy of airway clearance. Here we assessed the effect of cardio-pulmonary exercise testing (CPET) on the distribution of ventilation using V-MRI and lung clearance index (LCI).

Methods: Patients performed two baseline 3D V-MRI's, and LCI was measured by washout of SF_6 on air. This was followed by a maximal CPET, after which V-MRI and LCI were repeated. The ventilation defect percentage (VDP) was used to quantify the proportion of lung without ventilation on V-MRI. The two baseline scans were used to assess VDP repeatability.

Results: 13 patients with CF were assessed; mean (SD) age=25.2 (10.1)years, FEV_1=-1.8 (1.7) z-score. VDP from baseline scans showed Bland-Altman limits of agreement of -1.8 to 1.4%; significant change in VDP was set at >1.6%.

Post-CPET, there was a significant reduction in VDP and LCI ($p<0.05$). 11/13 patients had a visual change in ventilation distribution: 9 subjects had at least partial resolution of defects whilst 2 patients had new ventilation defects appear. Overall 7/13 patients had significant change in VDP. The 2 patients with new ventilation defects post-CPET both had normal FEV_1 (>-1.64 z-score) but also low VO_2 at peak exercise and anaerobic threshold (AT), and were outliers when correlating VO_2 with VDP. Excluding these 2 outliers, VDP significantly correlated with VO_2peak (r=-0.86) and VO_2AT (r=-0.88).

Conclusions: For some patients, acute maximal exercise directly affects the distribution of ventilation in CF, likely due to re-distribution of mucus caused by large increases in ventilation during exercise. Deconditioned patients may benefit from exercise-based airway clearance.

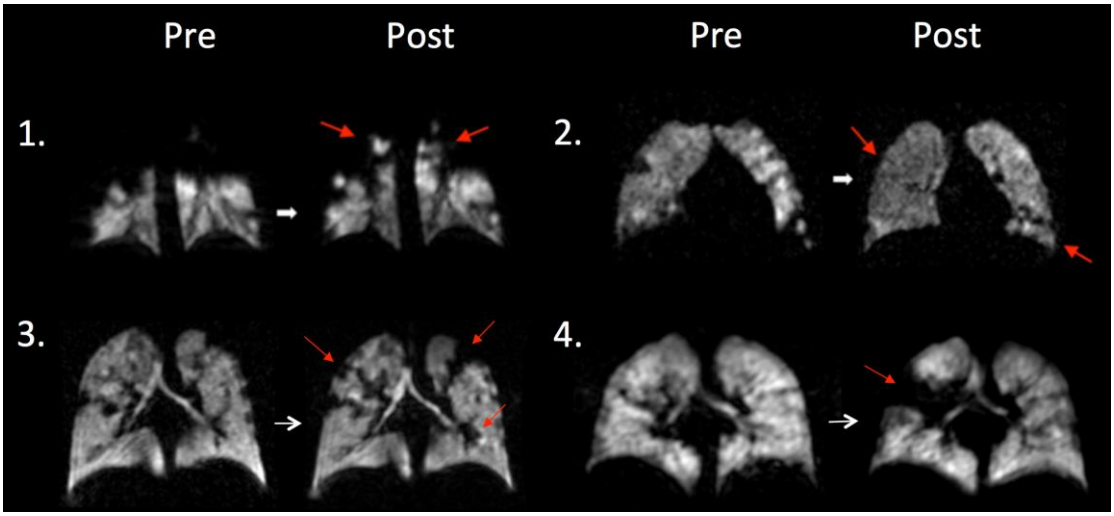

Figure 1: ^{129}Xe ventilation MRI in four patients (1-4) pre and post CPET. Post exercise, patients 1 and 2 have significantly improved VDP and have areas of visual improvement in the distribution of ventilation. In contrast, patients 3 and 4 have a worsening in the distribution of ventilation post exercise, with new ventilation defects appearing. Red arrows depict areas of the lung, which have either improved ventilation post exercise, or depict a worsening in ventilation.

P36

P36 - An Evaluation of Concordance of Sleep Stage Scoring: Evidencing Standards and Quality Assurance in NHS Lothian

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An Evaluation of Concordance of Sleep Stage Scoring: Evidencing Standards and Quality Assurance in NHS Lothian

Introduction

In 2013, the American Academy of Sleep Medicine (AASM) published results from the Inter-Scorer Reliability (ISR) programme in the Journal of Clinical Sleep Medicine [(1)]. The conclusions detailed suggest that whilst using AASM guidelines for scoring, concordance and inter-scorer agreement of sleep stage scoring should exceed 83%. As a method of monitoring quality assurance in sleep stage scoring in NHS Lothian, required concordance should exceed 85% with comparison to a Senior Sleep Physiologist in possession of the RPSGT certificate. This standard conforms and exceeds the expected concordance stipulated by the AASM.
The purposes of this evaluation are to ensure inter-scorer agreement standards continue to exceed AASM recommendations and local concordance protocol levels, and to provide an ongoing record of quality assurance for the Sleep Service in NHS Lothian.

Method

Between April 2018 and January 2019, four concordance studies were set by the Chief Physiologist. Sleep Physiology staff (n = 8; n = 1 Chief Physiologist and n = 7 Sleep Physiologists), were required to score the set studies and concordance of Apnoea Hypopnoea Index (AHI) and sleep stage scoring (total concordance, N2 and N3, Wake, NREM, REM) were compared to the Chief Physiologist study. Trends in data were identified and discussed.

Results

	Study 1 (±SEM)	Study 2 (±SEM)	Study 3 (±SEM)	Study 4 (±SEM)	Four-Study Average (±SEM)
Sleep Staging Total Concordance (%)	91.00% (±1.26%)	79.50% (±4.59%)	90.80% (±1.92)	81.00% (±1.41%)	85.58% (±6.18%)
Sleep Staging Concordance N2 and N3 (%)	92.17% (±0.75%)	82.33% (±4.76%)	92.80% (±1.92)	83.00% (±1.41%)	87.58% (±5.68%)
Sleep Staging Concordance Wake, NREM and REM (%)	95.00% (±0.89%)	89.17% (±3.49)	95.20% (±1.30)	88.50% (±0.71%)	91.97% (±3.63%)
AHI (Absolute/Average)	22.43/16.59	13.21/11.47	20.00/27.20	10.39/7.01	12.11/9.59

Discussion

Concordance over the four-study average indicates inter-scorer agreement standards continue to exceed AASM recommendations and local concordance protocol levels (range 85.58% - 91.97%). Minimal variations in AHI were noted between the Chief Physiologist and inter-scorer agreement, indicating no difference in treatment options or variation in patient outcome.

References

1. Rosenberg RS; Van Hout S. The American Academy of Sleep Medicine inter-scorer reliability program; sleep stage scoring. *J Clin Sleep Med* 2013;9(1):81-97.

P37

P37 - A retrospective review of survival following non-invasive ventilation supported percutaneous endoscopic endoscopy in patients with motor neurone disease.

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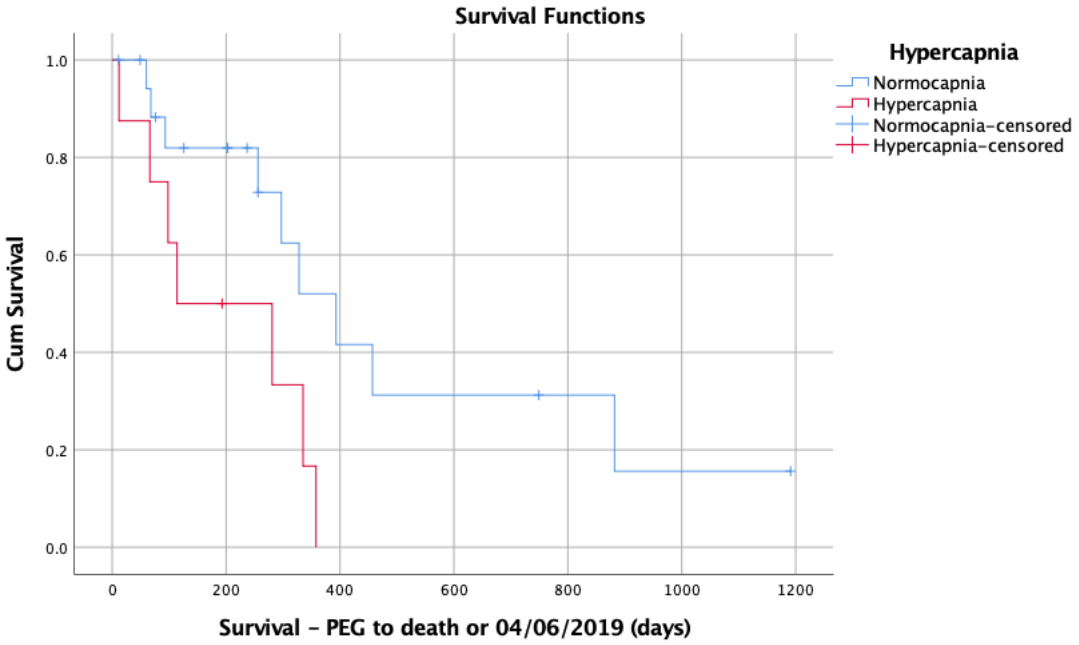
Motor Neurone Disease (MND) is a neurodegenerative disease resulting in progressive muscle weakness leading to impaired control of movement, breathing and swallowing. Malnutrition is associated with a decrease in muscle strength and increased patient mortality[1]. Percutaneous endoscopic gastrostomy (PEG) placement is indicated in patients with symptomatic dysphagia and/or significant weight loss[2].

Despite limited data to support the specific timing of PEG, it is generally recommended before forced vital capacity (FVC) falls below 50% predicted[3]. Due to the risk of PEG placement in MND patients with respiratory compromise, non-invasive ventilation (NIV) is being increasingly used as ventilatory support during the procedure. We undertook a retrospective review of outcomes of NIV supported PEG procedures in our MND population.

Between 30.07.2013 and 24.05.2019, 31 (18M) patients, mean age 66.87 +/- 8.74 years underwent gastrostomy supported by NIV. One patient died within 30-days (12 days) of PEG placement. Overall mean survival was 402 +/- 77.20 days. Survival was not influenced by MND site of onset (bulbar or limb) (Log Rank p=0.156) or prior use of NIV (Log Rank p=0.123). Only 3/26 (12%) patients had an FVC <50% predicted (1/3 achieving quality assured standards) and this was not found to influence survival (Log Rank p=0.695). A significant survival difference was observed in hypercapnic patients ($paCO_2$ >6.0kpa) (Figure 1) prior to PEG (Log Rank p=4.669, p 0.031). Cox-regression analysis however (HR 8.9, 95% CI 0.893-89.47, p 0.062) demonstrates that this was not statistically significant.

In our single centre, small cohort study, our data suggests that pre-procedure hypercapnia may offer additional prognostic information. Mean survival in our patient group was better than that reported in the literature (402 (95% CI 184 to 389), 260 (95% CI 209 to 297), respectively) days. Sequential measurements of FVC are important in the monitoring of respiratory compromise however ABG measurements are also recommended to allow holistic patient assessment especially as the accurate determination of FVC can be difficult in patients with predominately bulbar impairment.

1. Desport, 1999
1. Miller, 2002
2. American Academy of Neurology


Survival Functions
Hypercapnia
Normocapnia
Hypercapnia
Normocapnia-censored
Hypercapnia-censored
Cum Survival
1.0
0.8
0.6
0.4
0.2
0.0
0
200
400
600
800
1000
1200
Survival - PEG to death or 04/06/2019 (days)

P38

P38 - Can anthropometric indices and Epworth Sleepiness Score (ESS) predict type of diagnostic test to investigate OSA?

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Can anthropometric indices and Epworth Sleepiness Score (ESS) predict type of diagnostic test to investigate OSA?

Introduction

OSA is the 3rd most common respiratory disorder in the UK (NICE, 2018), and is estimated that 1.5 million adults are affected, with a possible 85% of those undiagnosed. The Sleep service at RSUH has seen an exponential increase in the number of referrals to the service, with on average a 17% increase per annum over the last 5 years. The current pathway involves patients initially having overnight oximetry however, if this is inconclusive, a limited sleep study follows. This aim if this study was to assess if anthropometrics could be used to predict the first line investigation.

Method

A retrospective three month audit of 208 patients (138 male, 70 female) referred to the sleep service was conducted. Information regarding diagnostic investigations and anthropometric values were obtained and compared. A p value of 0.05 was used as the level of significance.

Results

Table 1

	Oximetry	Oximetry + LSS		CPAP after oximetry + LSS	Discharged after oximetry + LSS	
Parameter	**Mean (SD)**	**Mean (SD)**	**p-value**	**Mean (SD)**	**Mean (SD)**	**p-value**
Age	54.78 (1.86)	50.65 (1.08)	*0.0504*	53.07 (13.04)	48.60 (14.04)	*0.0246*
BMI	37.63 (1.23)	32.237 (0.576)	*0.0001*	33.59 (6.586)	30.75 (7.83)	*0.0052*
ODI	51.59 (3.65)	7.110 (0.634)	*<0.0001*	9.939 (9.272)	3.293 (1.94)	*<0.0001*
Collar size	17.673 (0.263)	16.513 (0.594)	*<0.0001*	16.444 (1.731)	16.76 (11.81)	*0.9020*
ESS	10.615 (0.666)	9.195 (0.447)	*0.0878*	9.820 (5.710)	8.068 (5.298)	*0.0724*
AHI		21.00 (1.63)		32.05 (20.45)	6.060 (4.570)	*<0.0001*
Male	39	99				
Female	13	57				

From the 208 patients, 52 (25%) went onto CPAP following oximetry. The remaining 156 required LSS, which confirmed CPAP in 88 cases. 61 were discharged and the remaining 7 went on to PSG. The oximetry confirmed CPAP group had increased BMI, ODI and collar size were generally older. When comparing the LSS confirmed CPAP with discharge or PSG, differences in BMI, ODI and AHI were seen.

Conclusion

The results show that age, BMI and collar size are useful predictors of OSA and a requirement for CPAP therapy. However, the measure of ODI and AHI remain the best measures for adherence to current guidance.