P1 - Reproducibility of Structured Light Plethysmography (SLP) in different positions

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Introduction:

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

Aim:

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

Methods:

Quiet breathing in 13 healthy volunteers was recorded via SLP (Thora^{3Di}, Pneumacare Ltd, Ely, UK). The same operator repeated the test in the same room on 2 different visits to test the reproducibility. The study protocol application for Ethical Review ERN_19-0016 has been fully approved after been reviewed by the Science, Technology, Engineering and Mathematics Ethical Review Committee at the University of Birmingham. The data were analysed using one way ANOVA with Tukey post hoc test.

Results:

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

Discussion & Conclusions:

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

Figure 1. a-h Comparing the Seated, Standing, and Supine Positions:

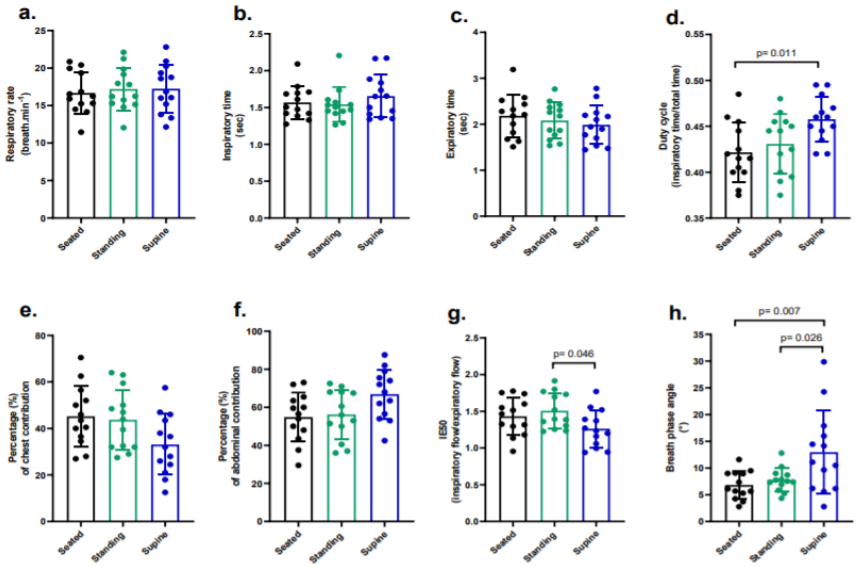

Figure 1. A one-way ANOVA with Tukey post hoc test to depict the difference between the three positions tidal parameters (a. Respiratory rate (RR), b. Inspiratory time (Ti), c. Expiratory time (Te), d. inspiratory to total time ratio (Ti/Ttot), and e. Inspiratory to expiratory flow at 50% tidal volume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

P2 - Thoraco-abdominal aneurysm case study and the multi-disciplinary approach to assessment and treatment.

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Introduction

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

Case Presentation

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

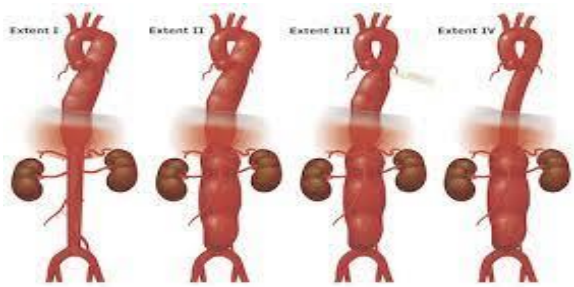

Figure 1. Classifications of TAAA (m.ufhealth.org)

Pre-Operative Assessment (TAAA)

Cardio-Pulmonary Exercise Test:

Protocol 15 Watts/minute ramp; Time – 11 minutes. Stopped due to leg discomfort; VO_2 Peak 16.9 (millilitres per minute per kilogram) 74% predicted; Anaerobic Threshold 12.2 (millilitres per minute per kilogram); Blood pressure response appropriate for rise during exercise. 0_2 pulse normal. Normal ECG.

Pulmonary Function Tests: Mildly Obstructive Defect FEV1 2.44 (72% predicted), FVC 4.03 (91% predicted). Pre-operative testing as an intervention improves a patient's recovery after surgery and a means of predicting both 30-day outcome and 30-month mortality.[2]

Outcome/Multi-Disciplinary Approach (MDA)

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

1. Aune, D., Schlesinger, S., Nora, T. et al (2018) Tobacco Smoking and the Risk of Abdominal Aortic Aneurysm: *A Systematic Review and Meta-Analysis of Prospective Studies*. Sci Rep (8) 14786

1. Thompson, AR., Peters, N., Lovegrove, RE., Ledwidge, S., Kitching, A., Magee, TR. (2011). Cardiopulmonary Exercise Testing Provides a Predictive Tool for Early and Late Outcomes in Abdominal Aortic Aneurysm Patients.

2. Ziganshin, BA., Elefteriades, JA. (2014). Surgical Management of Thoraco-Abdominal Aneurysms. *Heart 100*: 1577-1582

P3 - A role for cardiopulmonary exercise testing in detecting physiological changes underlying health status in Idiopathic pulmonary fibrosis: a feasibility study

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Introduction: There is limited data on the use of cardiopulmonary exercise testing (CPET) as a predictive tool for disease outcomes in patients with idiopathic pulmonary fibrosis (IPF). We investigated the feasibility of undertaking CPET and the relationship between CPET outcomes and quality of life measurements in patients with mild and moderate IPF.

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

Table 1 baseline and 1 year follow up data for patients within mild group (those with matched tests)

All values are shown as mean ± standard deviation, unless otherwise stated. Paired t-test was used for parametric data, whilst Wilcoxon matched pairs signed rank test was used for non-parametric data. A $p < 0.05$ was considered statistically significant.

Methods: Patients completed lung function, six minute walk (6MWT), CPET, health status questionnaires (K-BILD and VAS cough and breathlessness) and patient-reported outcomes (IPF-PROM). Patients with mild IPF repeated the study investigations at 12 months.

Results: Twenty-one patients (mild n=13 and moderate n=8) completed the study.
At baseline, total K-BILD and total IPF-PROM scores significantly correlated with 6MWT distance, but not baseline FVC %predicted, TLco %predicted, baseline or minimum SpO2. VO_2 peak/kg at AT positively correlated with total scores, breathlessness/activity and chest domains of the K-BILD questionnaire ($p < 0.05$). VO_2 peak significantly correlated with total IPF PROM scores and wellbeing domains ($p < 0.05$), with a trend towards statistical significance for total IPF-PROM and VO_2 peak/kg at AT ($p = 0.06$). Repeat CPET testing demonstrated statistically significant changes compared to baseline values (Table 1).

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

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

P7 - Quality of home spirometry trials using Hand Held Spirometers in CF and Bronchiectasis patients

Miss Hina Mir[1], Ms Rasheda Choudhury[1], Dr Caroline Pao[1]

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

Introduction

Spirometry requires maximum patient effort in order to achieve acceptable and repeatable results. Verbal and visual feedback is given to patients to correct technique and improve the quality of spirometry data in outpatient clinics. This is in line with ATS/ERS 2005 criteria on acceptability and repeatability. Sophisticated spirometers provide feedback to the patient on test performance and repeatability at home, in order to obtain good quality data in the absence of a physiologist.

To determine the repeatability of home FEV_1 and FVC data collected using the NuvoAir in adolescent patients with CF and bronchiectasis. To compare the NuvoAir independent results to the hospital Vyaire spirometry results.

Method

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

Results

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

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

Parameter	Hospital Vyaire PEF (L/s) Result	Hospital Vyaire FEV_1 (%) Result	Hospital Vyaire FVC (%) Result	NuvoAir PEF (L/s) Result	NuvoAir FEV_1 % Result	NuvoAir FVC% Result
Average	6	79	90	6	83	94
SD	2	19	13	2	19	16

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

Conclusion

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

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

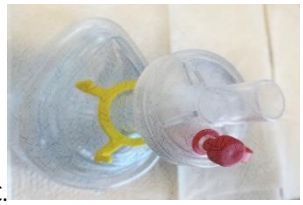
P8 - Comparison of different interfaces for multiple breath inert gas washout technique

Miss Hina Mir[1], Ms Rasheda Choudhury[1], Dr Caroline Pao[1]

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

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

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

A.  B.  C. 

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

Results:

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

FRC = functional residual capacity; LCI 2.5% norm = normalised lung clearance Index at 2.5%; RQ= respiratory quotient; VT = tidal volume; VdCO2 = volume of gas coming from dead space

RQ is assumed to equate to respiratory exchange ratio at rest and is calculated as volume of CO2 expired /volume of O2 consumed. Normal RQ range is between 0.8 – 1.0, and represents stable breathing. Abnormal RQ can be due to hyper/hypoventilating or presence of a leak. All interfaces RQ remained within 0.9-1.1, which suggest the absence of any leak or unstable breathing.

Mouthpiece vs Mouth guard – LCI 2.5 values were within 9.3%. Our between tests FRC was within 2.9% of each other. Mouth guard vs Mask – LCI 2.5 values were within 0.3%. Our between tests FRC was within 13.8% of each other.
Mask vs Mouthpiece – LCI 2.5 values were within 9.0%. Our between tests FRC was within 10.5% of each other.

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

P9 - A Virtual SIC: A new way of diagnosing occupational asthma in the COVID-19 pandemic

Dr Vicky Moore[1], Prof Sherwood Burge[1], Dr Christopher Huntley[1], Dr Alastair Robertson[1], Dr Gareth Walters[1]
[1]*University Hospitals Birmingham, Birmingham, West Midlands*

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

Methods: The worker completed virtually supervised FEV1 and PEF measurements (using the Vitalograph asma-1), then went to a separate room where she wore one of the masks; Day 1: surgical mask for 1.5 hours; day 2 surgical mask for 3 hours; day 3 – rest day; day 4 FFP3 for 3 hours. She performed hourly readings until bed (supervised during working hours). The following week, she wore the surgical mask Monday-Friday during working hours performing hourly FEV1/PEF. After an 8 week break, an airfed helmet was tested in the same way for a week.

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

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

P10 - Stay home; save lives; aid the diagnosis of occupational asthma

Dr Vicky Moore[1], Prof Sherwood Burge[1], Dr Christopher Huntley[1], Dr Alastair Robertson[1], Dr Gareth Walters[1]
[1]*University Hospitals Birmingham, Birmingham, West Midlands*

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

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

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

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

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

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

P11 - An RER of 1.05 should not be used to determine maximal effort during CPET

Max Thomas[1], Dr James Hull[2], Dr Karl Sylvester[3]

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Intro:

A recent ERS statement on standardisation of cardiopulmonary exercise testing (CPET) in chronic lung diseases (Radtke et al 2019) discussed the criteria for determining maximal effort. A CPET with a respiratory exchange ratio (RER) >1.05 is considered maximal using these criteria; V'O2 <85% predicted, V'E >85% predicted, and HR <90% predicted were considered abnormal responses if the test is maximal.

We hypothesise that using an RER >1.05 as maximal will result in misinterpretation.

Methods:

Retrospective analysis of CPETs performed at Birmingham Heartlands Hospital in 2019. Inclusion criteria: patient limited, RER >1.15 at peak, >6 mins. Exclusion criteria: highly variable RER indicating dysfunctional breathing.

V'O2, V'E, and HR were measured at RERs of 1.05, 1.15 and peak, and were compared with Friedman tests.

Results:

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

Table 1. CPET Data (median±IQR)

	RER 1.05	RER 1.15	Peak	p
V'O2 %pred	54.25 ± 22.2	65.2 ± 25.8	76.1 ± 30.7	<0.0001
V'E %pred	38.4 ± 17.8	53.7 ± 22.25	65 ± 24.44	<0.0001
HR %pred	77.55 ± 17.55	86.9 ± 16.17	91.46 ± 16.95	<0.0001

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

Of the 117 preoperative assessments, 88 had a V'O2peak >15 ml/min/kg and could be considered low risk for surgical intervention. At an RER of 1.05, 70% of these patients would have been considered high risk; 30% would have been considered high risk at RER 1.15.

Discussion:

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

P12 - Pulmonary function after COVID-19 infection and the impact of disease severity.

Max Thomas[1], Dr Ha-Kyeong Won[2], Dr Oliver Price[3], Dr Woo-Jung Song[4], Dr James Hull[5]

[1]University Hospitals Birmingham, UK, [2]VHS Medical Center, South Korea, [3]Leeds Beckett University, UK, [4]University of Ulsan College of Medicine, South Korea, [5]Royal Brompton Hospital, UK

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

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

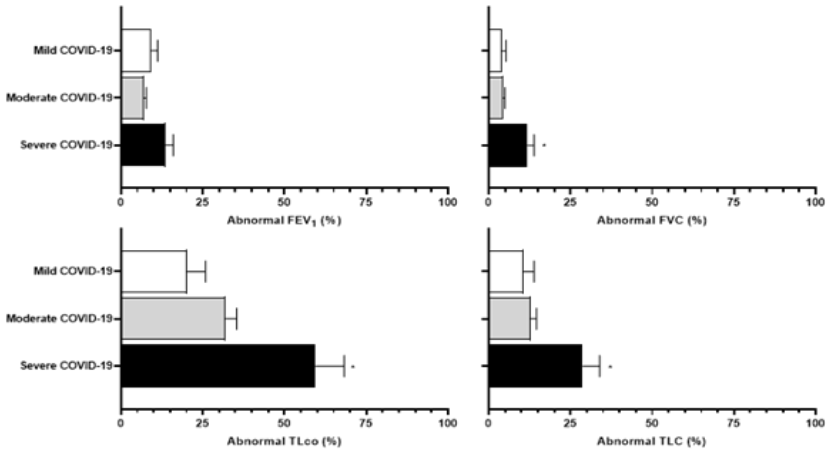
Methods:
PubMed and Embase were searched for studies including PFT data in patients who have recovered from COVID-19. To be included in the analysis the FEV1, FVC, TLco and/or TLC data needed to be stratified by severity (mild, moderate, and severe) and presented as frequency below the lower limit of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

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

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

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

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



P13 - The implications of adopting the Global Lung Function Initiative (GLI) equations in an adult non-caucasian patient population in Berkshire.

Miss Natalie Wilson[1], Mr Mark Unstead[1]

[1]*Royal Berkshire NHS Foundation Trust, Reading, United Kingdom*

Category: A

Introduction: The implications of adopting the GLI reference equations for gas transfer and spirometry have been evaluated in caucasians. However, there has been less research into the impact on non-caucasians.

Aims: To assess the impact of adopting the GLI equations for spirometry and gas transfer in an adult non-caucasian patient population in Berkshire.

Methods: The GLI and ECSC reference equations were applied to a sample of non-caucasian patients (n=100). Predicted values and lower limits of normal for GLI and ECSC were compared using paired t-tests and Wilcoxon signed-rank tests. Differences in severity of impairment and airflow obstruction were also compared using percentages and the kappa statistic. Finally, the mean differences in predicted values and LLNs between caucasians (n=50) and non-caucasians were compared using Mann-Whitney U tests.

Results: In males, GLI predicted values and LLNs were significantly higher (FVC, FEV1, TLCO, KCO and VA) ($p<0.0001$). In females, GLI predicted values and LLNs were significantly higher for all measurements ($p<0.0001$) apart from predicted TLCO and KCO, which were significantly lower ($p<0.0001$). There was moderate agreement for severity of airflow obstruction (75%, kappa=0.619) between GLI and ECSC, but minimal agreement for interpretation of FVC in both males and females (kappa=0.242 and 0.073, respectively). Agreement for interpretation of TLCO was weak in males (62%, kappa=0.477) and minimal in females (55%, kappa=0.371). Agreement for KCO was minimal in males (71%, kappa=0.318) and weak in females (87%, kappa=0.585). Changes in reference values significantly differed between non-caucasians and caucasians. Agreement between GLI and ECSC was better in caucasians than non-caucasians for all measurements apart from KCO in females.

Conclusions: Adopting the GLI reference equations will affect the interpretation of lung function and may increase the prevalence of restriction and impaired gas transfer in non-caucasians. The multi-ethnic spirometry equations are thought to be more representative thus suggesting that restriction has previously been underdiagnosed in non-caucasians. The GLI gas transfer equations are derived from caucasians therefore they should be used with caution in non-caucasians.

P14 - Early cost utility analysis comparing eXciteOSA to Continuous Positive Airway Pressure in mild obstructive sleep apnoea (OSA)

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

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

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

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

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

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

	eXciteOSA	CPAP
Treatment costs	**£3,393.43**	**£3,336.45**
Device	£1,186.11	£1,001.06
Consumables	£1,948.16	£1,168.22
Set-up & training	£41.43	£463.66
Annual review / servicing	£217.72	£703.52
Untreated OSA Healthcare Costs	**£131.16**	**£216.55**
QALY gain	**0.20**	**0.15**
Difference in Costs (vs CPAP)	**-£28.41**	
Difference in QALYs (vs CPAP)	**-0.05**	
Incremental cost-effectiveness (vs CPAP)	**Dominates (cost saving and better outcomes)**	

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P15 - Potential health economic impact of untreated mild OSA compared to treatment with eXciteOSA

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This research was funded by Signifier Medical Technologies

Background
Mild obstructive sleep apnoea (OSA) is largely untreated due to poor tolerance to available therapies [1, 2]. eXciteOSA is a novel day-time therapy, demonstrate to be well tolerated and improve symptoms of mild OSA [3, 4].
Objective
We aimed to estimate the cost-effectiveness of eXciteOSA compared to no treatment in mild OSA, from a national health service (NHS) England perspective.
Methods
An early stage, cost utility analysis calculated difference in costs and quality adjusted life years (QALYs) in a cohort of mild OSA suffers, in quarterly intervals in year 1, and annually thereafter for 14 years.
Treatment costs included patient set-up, equipment, and monitoring costs. Untreated mild OSA was assumed to incur additional healthcare costs of £39.38 / per patient per year (PPPY) [5] sourced from a CPAP trial in mild/moderate patients. ExciteOSA discontinuation rates were estimated, informed by clinical trials [3, 4] and clinician feedback. Where patients stopped treatment, no further treatment costs were incurred. A utility benefit of eXciteOSA 0.023 per year on treatment was calculated, replicating an approach applied in prior economic evaluations [6] using change in Epworth sleepiness scale (ESS) [9.0 before eXciteOSA, 5.1 post-eXciteOSA][4] Future costs and outcomes were discounted by 3.5%.
A scenario analysis explored a hypothesis that effective treatment for mild OSA avoids progression to more severe disease associated with higher morbidity. Here, we applied a higher costs for untreated OSA (£80.38 PPPY) [7] and a greater utility benefit on treatment (0.04 PPPY) [8].
Results
After 14 years, eXciteOSA incurred higher costs (£3,525) and resulted in better outcomes (0.20 QALYs) per patient compared to no treatment. The incremental cost-effectiveness ratio (ICER) was £15,289 per QALY (Table 1). When cost offsets and utility gains associated with treating moderate or severe OSA were applied, the ICER decreased to £7,919 per QALY.
Conclusions / Recommendations
Early economic analysis suggests that eXciteOSA is likely to be considered a cost-effective (under £20,000 - £30,000 QALY typically accepted)[9] treatment for mild OSA. This economic case for adopting eXciteOSA may be even greater if low burden of use ensures adherence is maintained and earlier intervention reduces risk of progression to more severe disease.

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

	eXciteOSA	No Treatment
Treatment costs	**£3,393.43**	**£0.00**
Device	£1,186.11	£0.00
Consumables	£1,948.16	£0.00
Set-up & training	£41.43	£0.00
Annual review / servicing	£217.72	£0.00
Untreated OSA Healthcare Costs	**£131.16**	**£467.65**
Difference in Costs (vs No Treatment)	**£3,056.94**	
Difference in QALYs (vs No Treatment)	**0.20**	
Incremental cost-effectiveness (vs No Treatment)	**£15,289**	

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P16 - How effective is Adaptive Servo Ventilation?

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Introduction

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

Methods

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

Results

Results showed that for all patients: baseline AHI = 35.7, ODI = 29.5 and mean SpO2= 92.7%. AHI on original device = 16 and average use on original device = 6.1 hours. In comparison to AHI on ASV = 1.9 events per hour, ODI on ASV = 3.4 dips and average use on ASV = 5.8 hours.

The 27 patients on no form of opiate: baseline AHI = 38 events per hour, baseline ODI = 34 and mean SpO2 = 92%. AHI on original device = 18 and AHI on ASV = 2. 17 patients were on some form of opiate. In this group the baseline AHI = 33 events per hour, baseline ODI = 23 and mean Spo2 = 94%. AHI on original device = 13 and AHI on ASV = 1.

Conclusion

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

P17 - Quality control of polysomnographic scoring in a clinical sleep physiologist team

Dr. Heather Engleman[1], Mr. Nuno Faria Cachada[1], Ms. Sara Hacking[1], Ms. Sarah Martin[1], Ms. Lauren Irwin[1], Ms. Neena Derashri[1]

[1]*Philips Respironics UKI, Farnborough, UK*

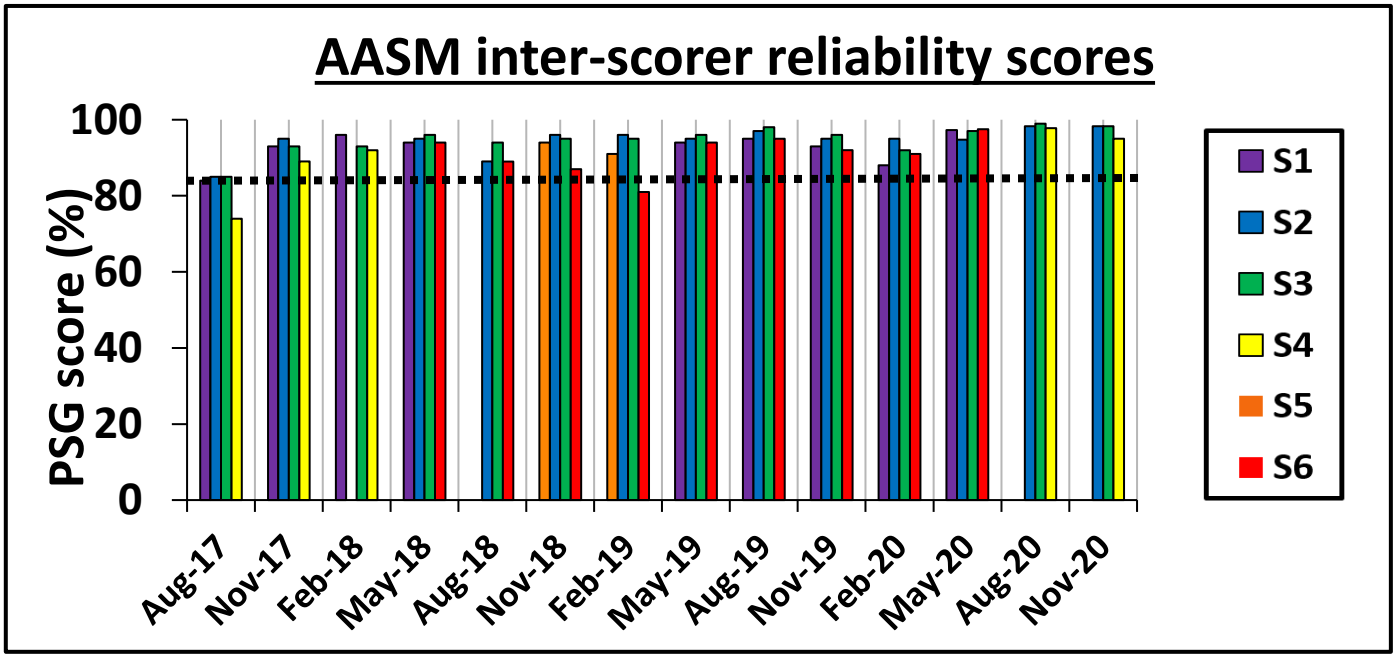
Objectives: To apply an external gold standard for polysomnographic scoring in a team of sleep physiologists, in order to align scoring practice, maintain learning and to assure quality control of scoring output.

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

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

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

Disclosure: All authors are employees of Philips Respironics UKI.



P18 - Does the method of delivery of nocturnal pulse oximetry affect the quality and reliability of results?

Ms Rachael Leach[1], Mrs Sara Parsons[1]

[1]*St George's University Hospital NHS Foundation Trust,*

Introduction

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

Method

In March 2020 the following methods of delivery were introduced:

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

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

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

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

Inclusion criteria:
Traces with more than four hours of reliable data

Exclusion criteria:

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

Results

The results collected are displayed in table 1.

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

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

Conclusion

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

P19 - Case Study: A patients' perspective of CPAP therapy pre and post bariatric surgery

Ms Rachael Leach[1], Mrs Sara Parsons[1]

[1]*St George's University Hospital NHS Foundation Trust*

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

CPAP minimum pressure was titrated to 14.0cmH20. Patient was compliant with CPAP therapy and AHI was optimised. In October 2018 patient underwent Roux-en-y Gastric Bypass surgery. Less than a month later, patient was struggling with CPAP due to high pressure; use of ramp function evident, which had not previously been used. This was despite only a 9kg (5.8%) weight loss. Minimum pressure was reduced to 8.0cmH20; AHI remained controlled, and CPAP compliance increased.

As a respiratory physiologist, patient performed regular biological controls in their department, and continued this during their weight loss. The pulmonary function results demonstrated an improvement post weight loss surgery (FEV1 18%, FVC 14%, FRCpleth 48%, ERV 35%, TLC 23% increase).

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

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

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

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

P20 - Magnitude of sleep quality and associated factors among undergraduate medical students in Nepal; a cross-sectional study

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[1]Institute Of Medicine, Tribhuwan University, Kathmandu, Nepal, [2]Center for Global Health, Department of Public Health, Aarhus University, Aarhus, Denmark, [3]Nepal Development Society, Chitwan, Nepal

Title: Magnitude of sleep quality and factor associated among undergraduate medical students in Nepal; cross sectional study

Background

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

Method

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

Result

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

Conclusion

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

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

P21 - Continuous Positive Airway Pressure (CPAP) adherence prior to and following the first surge of the COVID19 pandemic

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CATEGORY: B

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

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

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

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

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

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

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P22 - How to improve Cpap compliance in Patients with Learning Disabilities

Mrs Suzannah Torres[1]
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Study shows: 54% Cpap compliance rate achieved i.e. usage >4hrs where previously no usage.

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

Methods:

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

Findings:

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

Conclusion:

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

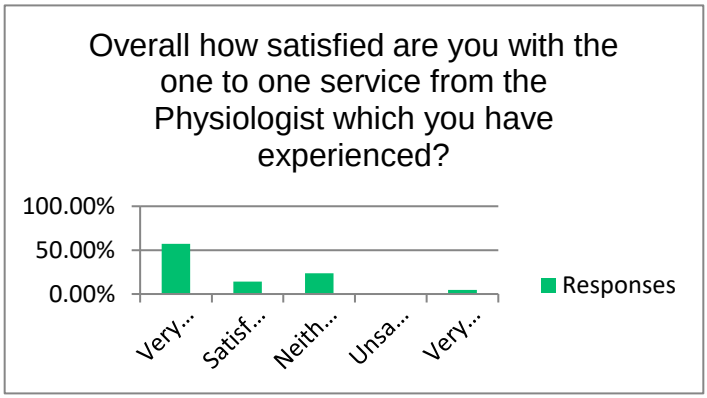

Figure 1. Patient feedback questionnaires regarding the new service pathway.
Feedback questionnaires were sent to a total of 80 patients. We received approximately 25% response. The Feedback was overwhelmingly positive.

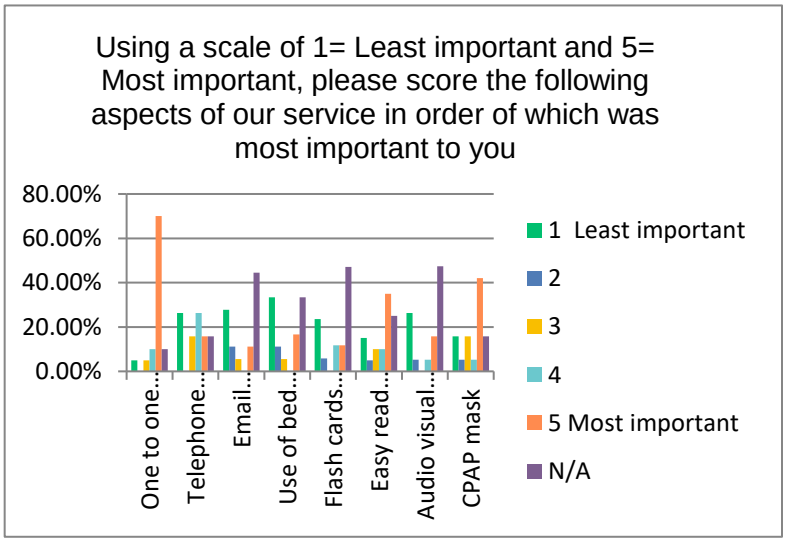

Figure 2. Patient Feedback questionnaire, in order of importance regards the different aspects to the new service pathway implemented. Patients preferred most the one to one approach, followed closely by cpap mask guides and easy read guides. The significance of this was that patients only communicated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

P23 - Continuous Positive Airways Pressure (CPAP) - Drive Thru Collection Clinic (DTCC).

Mrs Karena Cranstone[1]

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INTRODUCTION

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

METHOD

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

RESULTS

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

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

Table 1. Results and key outcomes.

CONCLUSION

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

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P24 - AI-based quality control of spirometry in large epidemiological studies: insights from UK Biobank

Dr. Nilakash Das[1,2], Mr. Armin Halilovic[2], Dr. Kevin Ray[2]

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Introduction

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

Methods

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

Results

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

Conclusion

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

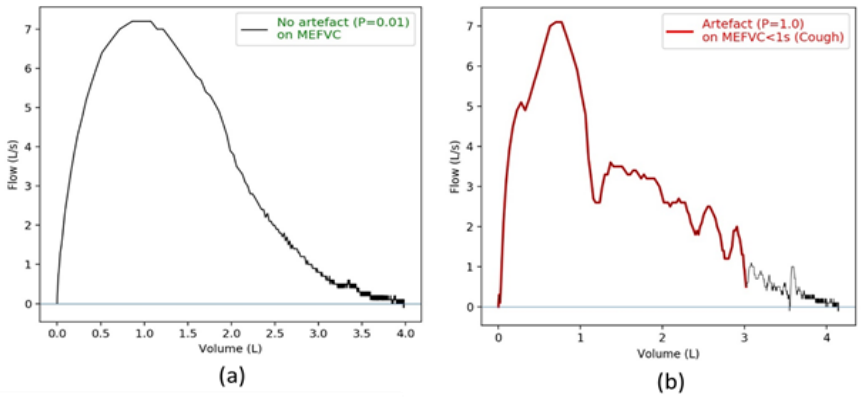


Figure showing two discrepant curves. In (a) curve was predicted as acceptable by ArtiQ.QC but labelled as unacceptable due to large time to peak flow by UK Biobank protocol. (b) Curve was predicted as unacceptable by ArtiQ.QC due to presence of cough but labelled as acceptable by UK Biobank protocol.

P25 - An audit of Primary Care spirometry services in Bristol, North Somerset and South Gloucestershire (BNSSG).

Catherine Dixon[1], Shannon Robbins[1], Colleen Riley[1]
[1]*North Bristol NHS Trust, Bristol,*

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

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

Results:
Thirty-three of 87 practices returned the questionnaire, of which 94% perform spirometry. The mean number of spirometry tests performed in the previous 12 months was 128 (range 15 – 525).
The majority of practices indicated staff had received spirometry training and the remaining 13% did not answer the question. No staff were on the full, foundation or paediatric level of the National Spirometry Register.
The frequency of equipment calibration, verification and cleaning varied, with 16% only performing calibration/verification of their spirometry equipment annually or never.
Twenty-eight (55%) of the results reviewed were technically acceptable and reproducible, one practice sent no technically acceptable/reproducible results. The most common error was failure to meet end of test criteria (table 1).

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

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

Table 1 Review of Spirometry Standards

Standard	**Number of tests not meeting the criteria**
BEV <5% of FVC or 0.100 L, whichever is greater	3/51
No cough or glottis closure in the first second of expiration	6/51
Achieve EOFE criteria	21/51
The difference between the two largest FVC and FEV1 values <5% or <0.100 L whichever is greater	3/51

P26 - Outcomes from a tertiary level home oxygen service during the COVID-19 pandemic.

Ms Elizabeth Dobson[1], Mr Edward Parkes[1], Mrs Joanna Shakespeare[1]
[1]*UHCW NHS Trust, Coventry, UK*

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

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

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

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

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

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

P27 - Predicting the implications of COVID19 on lung function waiting lists across Wales

Christopher Earing[1], Lois Attewell[2], David Clough[3], Rob Holwill[4], Joleta Hooper-Lee[5], Hannah Hunt[2], Kimberley Lewis[6]

[1]The Pulmonary Function Department, Ysbyty Gwynedd, Betsi Cadwaladr University Health Board, Bangor, Wales, [2]Lung Function Department, Llandough Hospital, Cardiff and Vale University Health Board, Cardiff, Wales, [3]Cardio-Respiratory Department, Wrexham Maelor Hospital, Betsi Cadwaladr University Health Board, Wrexham, Wales, [4]Lung Function, Morrison Hospital, Swansea Bay University Health Board, Morrison, Wales, [5]Lung Function, Singleton Hospital, Swansea Bay University Health Board, Swansea, Wales, [6]Powys Teaching Health Board, Powys, Wales

Category: C - Quality Improvement and Patient Safety

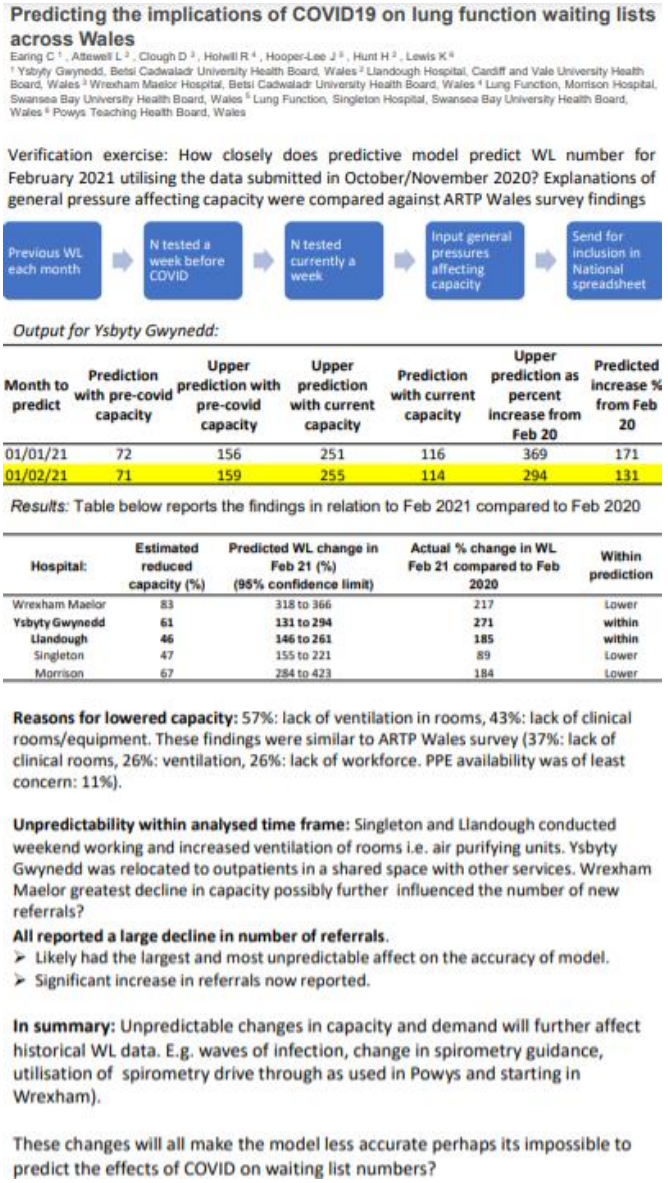
Surveys appear limited in their ability to predict the future impact of COVID 19 on waiting list (WL) numbers. If future WL numbers could be accurately estimated proactive plans could be put in place. Following information on capacity/demand requested via the Welsh Scientific Advisory Committee (WSAC),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

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

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

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

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



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

Earing C [1], Attewell L [2], Clough D [3], Holwill R [4], Hooper-Lee J [5], Hunt H [2], Lewis K [6]

[1] Ysbyty Gwynedd, Betsi Cadwaladr University Health Board, Wales [2] Llandough Hospital, Cardiff and Vale University Health Board, Wales [3] Wrexham Maelor Hospital, Betsi Cadwaladr University Health Board, Wales [4] Lung Function, Morrison Hospital, Swansea Bay University Health Board, Wales [5] Lung Function, Singleton Hospital, Swansea Bay University Health Board, Wales [6] Powys Teaching Health Board, Wales

Verification exercise: How closely does predictive model predict WL number for February 2021 utilising the data submitted in October/November 2020? Explanations of general pressure affecting capacity were compared against ARTP Wales survey findings

Previous WL each month → N tested a week before COVID → N tested currently a week → Input general pressures affecting capacity → Send for inclusion in National spreadsheet

Output for Ysbyty Gwynedd:

Month to predict	Prediction with pre-covid capacity	Upper prediction with pre-covid capacity	Upper prediction with current capacity	Prediction with current capacity	Upper prediction as percent increase from Feb 20	Predicted increase % from Feb 20
01/01/21	72	156	251	116	369	171
01/02/21	71	159	255	114	294	131

Results: Table below reports the findings in relation to Feb 2021 compared to Feb 2020

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

Reasons for lowered capacity: 57%: lack of ventilation in rooms, 43%: lack of clinical rooms/equipment. These findings were similar to ARTP Wales survey (37%: lack of clinical rooms, 26%: ventilation, 26%: lack of workforce. PPE availability was of least concern: 11%).

Unpredictability within analysed time frame: Singleton and Llandough conducted weekend working and increased ventilation of rooms i.e. air purifying units. Ysbyty Gwynedd was relocated to outpatients in a shared space with other services. Wrexham Maelor greatest decline in capacity possibly further influenced the number of new referrals?

All reported a large decline in number of referrals.

- Likely had the largest and most unpredictable affect on the accuracy of model.
- Significant increase in referrals now reported.

In summary: Unpredictable changes in capacity and demand will further affect historical WL data. E.g. waves of infection, change in spirometry guidance, utilisation of spirometry drive through as used in Powys and starting in Wrexham).

These changes will all make the model less accurate perhaps its impossible to predict the effects of COVID on waiting list numbers?

P28 - New sleep diagnostic pathway – going contactless for COVID-19

Ms Ana Gaspar[1], Mrs Marta Vilaca[1], Mr Jack Ridler[1], Mrs Priya Nair[1], Mr Jonathan Poole[1], Mr Joel Patasin[1], Miss Danielle Ally[1], Mr Gregory Marsh[1], Dr Alison McMillan[1]

[1]East And North Hertfordshire NHS Trust, Stevenage, Hertfordshire

Introduction

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

Method

The patient pathway was re-designed to include a telephone clinic appointment collecting pre-assessment information, a diagnostic pack collection from a locker and the return to a drop-off box. The diagnostic pack included a respiratory polygraphy or oximetry device, instructions and questionnaires.
We compared data for patients undergoing assessment on October 2019 and October 2020.

Results

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

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

Conclusion

The change in patient pathway was clearly designed for patient safety and has improved clinical capacity without a significant increase in failed studies. However, it has had a negative impact on diagnostic data quality.
The clinical impact of this has not yet been assessed. Future studies could address whether the reduction in data quality may lead to clinically relevant outcomes.

P29 - Management of Patients on Continuous Positive Airway Treatment: Quality Improvement project on Remote Monitoring in Obstructive Sleep Apnoea

Dr Abubacarr Gassama[1], Ms Shirley Coelho[1], Mr Maximillian Thomas[1], Dr Rahul Mukherjee[1]
[1]*Birmingham Heartlands Hospital, Birmingham, United Kingdom*

Introduction:

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

Method:

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

Results:

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

Conclusion:

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

P30 - The evolving role of the Respiratory Physiologist in managing patients with stable ILD

Mrs Rebecca Griffiths[1]

[1]*Princess Of Wales Hospital, Bridgend, UK*

Category: C

Introduction and Objectives: Interstitial Lung Disease (ILD) is an umbrella term for a group of diseases which affect the interstitium that surrounds the alveoli, and can lead to dry cough, fatigue, hypoxia and dyspnoea. ILD can be progressive, irreversible and fatal, and early diagnosis and regular monitoring are key in managing patients. Given the number of subgroups which can be classified as ILD, it is difficult to estimate the prevalence of the disease, and it includes (though is not limited to) Idiopathic Pulmonary Fibrosis (IPF), Sarcoidosis and Hypersensitivity Pneumonitis.
Historically, patients were reviewed in an outpatient clinic by a specialist respiratory consultant, referred to respiratory physiology for pulmonary function testing (PFTs) and re-reviewed by the consultant with the results several months later.
We proposed to streamline this process, and ease the demand on the consultant-led service by incorporating a PFT with a clinical review for patients with known stable disease.

Methods: There are currently 195 patients on our hospital ILD database. We established strict criteria to identify patients with stable ILD: those with an established diagnosis, stable lung function results (<10% decline in FVC in 6 months), are symptomatically stable, a minimum of two previous consultant reviews, and not on disease-modifying drugs.
Eligible patients were referred to a Physiologist-Led ILD clinic (P-ILD) to ensure regular 6-monthly PFTs and a clinical review, including history, symptom review and examination in one appointment.
These stable patients were only re-referred to the consultant should their PFTs significantly decline, if they fall into the range for antifibrotic treatment, or if they should become increasingly symptomatic and require a symptom management plan.

Results: Out of 195 patients on our ILD database, 82 (42%) were identified as having stable disease and referred to the P-ILD service for 6 monthly review. By running one P-ILD clinic per week, this has significantly reduced waiting times for consultant-led clinics, and subsequently improved the median time for referral to diagnosis from 247 days (pre-2019) to 90 days (post 2019). It has also provided a cost saving of £268 per clinic (consultant vs physiologist).
Furthermore, 73% (19) of the 26 patients who responded to a patient satisfaction questionnaire on the P-ILD service agreed or strongly agreed that the care they receive in P-ILD is 'just about perfect', although almost 30% of patients (8) felt that they would like to see a doctor at each consultation, indicating that there is still work to be done to alter patients perception that consultants-led clinics are the only and best option for their delivery of care.

Conclusion: This method has enabled the ILD lead consultant to focus on more complex cases, provided a cost-effective way of managing these patients, reduced the number of hospital appointments for the patient, and improved patient safety by ensuring regular and timely reviews.

P31 - Development of a Telephone Consultation Triage System for Urgent Home Visit for Long Term Oxygen Therapy (LTOT) Patients During the COVID-19 Pandemic

Mrs Jodie Hunt[1], Mrs Amanda Coles[1], Miss Eve Gelencser[1], Prof Brendan Cooper[1]
[1]*University Hospitals Birmingham, Birmingham, United Kingdom*

INTRODUCTION: During the first COVID-19 national lockdown, all non-urgent face-to-face clinic appointments were converted to telephone consultations to reduce footfall into the hospital. For patients on LTOT, routine clinic appointments include blood gases measurement on their current prescription to ensure treatment is optimised and safe. Many patients purchase their own oximeters to measure saturation (SpO_2), although patients with type 2 Respiratory Failure also require measurement of pCO_2. We reviewed the oxygen telephone clinic to determine if it could potentially reduce the number of face-to-face reviews (at hospital and home) after the COVID-19 pandemic has resolved.

METHODS: The study took place over 6 months. To triage which patients required a home visit for blood gas measurement, we developed a telephone consultation escalation form with specific criteria that would flag this requirement. Criteria included (i) patients reporting symptoms of hypercapnia (e.g. headache, grogginess, confusion, bounding pulse or skin flushing), (ii) reports of consecutive measured saturations below target range or (iii) safety concerns that would warrant an environmental check to a safeguarding risk. Telephone calls were allocated 20 minutes whereas home visits were allocated 60 minutes.

RESULTS: 163 oxygen clinic telephone reviews were undertaken in 6 months (Table 1). 81 reviews resulted in escalation to a home visit, although 23% of these were for routine annual blood gas review (non-urgent). Home oximetry monitoring detected 23 patients (14%) with an SpO_2 below their target.

CONCLUSIONS: LTOT reviews by telephone are sufficient for 50% patients. As they take 40 minutes less than home visits, the continuation of telephone triage clinics after the COVID-19 pandemic should significantly increase capacity and ensure high priority patients are reviewed sooner. Issuing home oximeters may be a cost-effective way of identifying patients with symptoms who need a home oxygen review.

Reason for Escalation	Number of Patients	% Total (n=163)
Annual blood gas (routine)	19	12
SpO_2 below target (own oximeter)	23	14
New discharge 1st clinic	1	0.6
Prescription review required	26	16
Hypercapnia symptoms	5	3
Safety concerns	5	3
Referral from HCP for urgent review	2	1
Number requiring escalation	**81**	**50**
Number requiring *URGENT* escalation	**62**	**38**

Table 1: A summary of the reasons for escalation from a telephone review to a home visit. 163 telephone reviews were undertaken and 81 (50%) required escalation but only 62 (38%) were considered urgent.

P32 - Running a paediatric diagnostic service in a pandemic and beyond

Dr Jo-anne Johnson[1,2]

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

Problem:

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

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

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

Interventions:

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

Results:

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

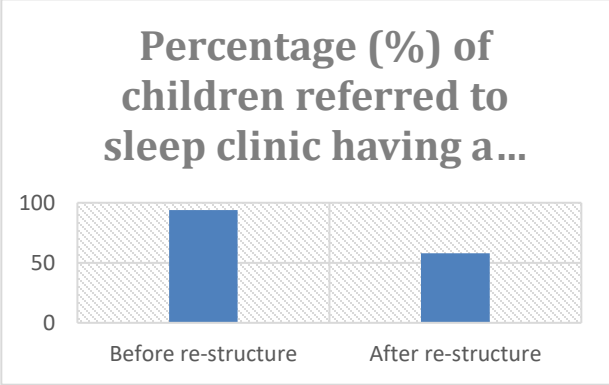


Figure a. Percentage of children referred to the sleep-disordered breathing clinic from any specialty for investigation of OSA undertaking an ambulatory overnight cardiopulmonary sleep study. 94% (72/77 patients) had a sleep study before re-structure compared to 58% (36/62 patients) after the re-structure.

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

Conclusions:

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

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P34 - How COVID 19 impacted Lung Function Testing at Royal London Hospital

Miss Hina Mir[1], Ms Rasheda Choudhury[1], Dr Caroline Pao[1]

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

Background

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

Method

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

Month	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
Patients	154	139	67	11	18	41	49	54	77	93	88	79	816

Results

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

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

To manage our patient's care and review patient's lung function, we purchased +50 home spirometers from NuvoAir to monitor our shielding patients. 74% of independent tests achieved the ATS/ERS 2005 repeatability criteria for FEV1. The machines allowed our patients to feel connected and supported while at home. We found this new service to be successful, results and have been utilising them during virtual clinics as this reduced face to face during COVID-19. We are aiming to order another 30 spirometers to expand the spirometry service.

Conclusion

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

P35 - The development of a spirometry data management interface for the international achieving asthma control in children in Africa (ACACIA) study

Miss Victoria Oyenuga[1], Mrs Lindsay Zurba[2], Mr Ian Sempill[3], Mr Andy Carter[4], Dr Gioia Mosler[1], Professor Jonathan Grigg[1]

[1]Queen Mary University of London, London, United Kingdom, [2]Education for Health Africa, Durban, South Africa, [3]Shelltech Software Ltd, Bristol, United Kingdom, [4]Carter Holmes Ltd, Cheltenham, United Kingdom

Introduction: The objective of the ACACIA study is to assess and explore asthma control in children in six sub-Saharan African countries using composite scores, FeNO and spirometry. The spirometry for each country (centre) needed to be quality assured before inclusion analysis.
Our aim was to create a bespoke and secure digital interface between the spirometry software and the study database with additional tools for quality assurance of the final spirometry data.

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

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

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

P36 - Overcoming the challenges of Covid-19 waiting lists: Drive through Spirometry, a service evaluation

Mrs Melanie Bryce[1], Mrs Tracey Herod[1], Mrs Lorraine Hyde[1], Mrs Kelly Pauley[1], Mr Alex Phythian[1], **Mrs Lauren Randall**, Mr Ashley Taylor[1], Mr Jordan Ulmer[1], Mrs Gemma Wells[1]

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

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

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

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

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

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

P37 - Do bacterial/viral filters impact quality assurance verification of ultrasonic spirometers

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

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

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

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

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

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

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

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

P38 - Development of a Drive-Thru Service for Sleep Diagnostic Studies During the COVID-19 Pandemic

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

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

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

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

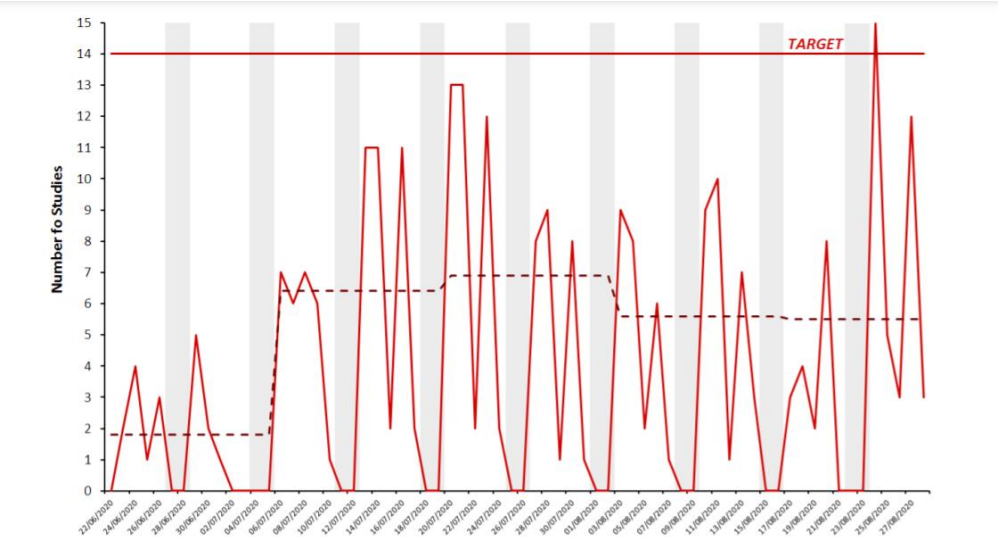

Figure 1: A Statistical Process Control (SPC) Chart for the total number of click-and-collect sleep studies during the first ten weeks (4 complete PDSA cycles) of service, showing the mean for each cycle (dotted line) and the target number (14). Grey areas indicate weekends when our department was not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

P39 - Benefits of a drive through overnight oximetry service during the pandemic of 2020-2021

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Introduction:

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

Method:

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

Results:

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

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

Conclusion:

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

References:

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

P41 - Short of circuits: a benchtop assessment of modified CPAP mask and circuits as part of pandemic response.

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Introduction

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

Method

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

Results

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

Table 1: Circuit Leak and F_iO_2 for MC and CE circuits. Mean (range) values displayed for CPAP of 10 cmH2O and 20 L/min Minute Ventilation.

Conclusion

Modified mask and circuits give a safe, effective alternative way of delivering acute CPAP in situations of critically low stock levels. Although the F_iO_2 delivery was lower in real-time patient use, the methods used in this study enabled rapid comparison between multiple circuit options.

References

1. Ashish A., et al. CPAP management of COVID-19 respiratory failure: a first quantitative analysis from an inpatient service evaluation. BMJ Open Resp Res 202