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SNews

ARTP Sleep Newsletter

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DATES FOR THE DIARY

2025
12th December ..... **National Strategy Day**

2025
21st-22nd May ..... **ARTP Annual Conference**

Editor's welcome

Welcome to the latest edition of ARTP SNEWS — a vibrant reflection of the innovation, collaboration, and clinical excellence shaping respiratory physiology today.

In this issue, we delve into the complexities of Obesity Hypoventilation Syndrome, exploring real-world case studies that highlight diagnostic challenges and therapeutic strategies. These insights not only deepen our clinical understanding but also underscore the importance of multidisciplinary care in managing this increasingly prevalent condition.

We're also thrilled to feature an exclusive interview with a leading respiratory physiologist from Australia, offering a global perspective on practice, training, and the evolving role of physiologists in patient-centred care. Their reflections remind us of the shared challenges and triumphs across borders — and the value of international dialogue.

Another key focus in this edition is reducing CPAP waiting times. With demand rising and resources stretched, we examine practical approaches and service redesigns that can streamline access and improve outcomes for patients with sleep-disordered breathing.

Finally, we proudly present a selection of abstracts from the ARTP Conference 2025, showcasing the cutting-edge research, audits, and innovations presented by our members. From novel technologies to service improvements, these abstracts reflect the energy and ambition driving our profession forward.

As always, thank you to our contributors and readers for making SNEWS a platform for learning, sharing, and growing together. We hope this edition informs, inspires, and sparks new conversations across our community.

Trish Matharu, ***Clinical Scientist***
Editor, ARTP SNEWS

If you have any topics that you would like to be covered in the next or future editions, please email them to admin@artp.org.uk.

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PROFESSIONAL

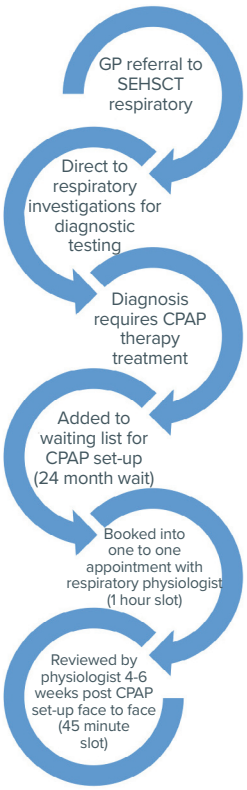
Making Dreams Possible with CPAP

Gemma Moss

We are a small department in the South Eastern Trust, that is understaffed, underfunded and battling waiting lists in all areas. Our main cause for concern was our 24-month waiting list for routine CPAP set up. This was 24 months from the point of referral for CPAP, meaning the patient journey was in fact much longer than 24 months from the timepoint of visiting their GP.

Factors that contributed to such a long waiting list included shortage of staff, an increasing demand on the sleep service, reduction in patient contact during the coronavirus pandemic, the shortage of CPAP machines during the global recall of devices as well as budget constraints limiting the purchasing of additional CPAP equipment. We were limited to setting up 6 patients on CPAP per week.

The original CPAP pathway in South Eastern Trust can be seen below.



It was decided that we had three options:

Option 1: No change and let the waiting list get continually longer

Option 2: Adjust the booking schedule to allow for more one-to- one hour-long CPAP set-up appointments to the detriment of a different waiting list

Option 3: Group CPAP set- up

We had a clear winner! Group set- up.

Once feasibility was established, viability was assessed. We evaluated impact on patient care, alignment with South Eastern Trust's objectives as well as long term sustainability. By seeing patients in a group environment, it would enable us to provide treatment to those who needed therapy faster, thus eliminating risks of untreated OSA and improving patient quality of life. All staff were excited at the prospect of a new way of working as well as a possible service improvement.

This new approach to getting patients established on CPAP therapy was implemented successfully after many meetings and much organisation. In August 2024 we held our first Group CPAP set-up with 12 patients being set up on CPAP in approx. one hour. We have successfully halved our waiting times from 24 months to 12 months and this is still improving. We obtained patient feedback via patient satisfaction questionnaires. Additionally, we have evaluated staff satisfaction questionnaires also. The feedback showed some conclusive points:

- Staff morale has improved, everyone enjoys participating in the Group set-up
- Positive feedback from patients that are seen in the group environment, it feels like a support group!
- Wider respiratory team delighted with improved service
- A recurring negative feedback concerned car parking therefore we amended first review from face-to-face to virtual

Overall a huge success!

PROFESSIONAL

Respiratory and Sleep Physiology Worldwide – An Interview

Eva McKenna

My name is Eva McKenna, and I am a Respiratory and Sleep Physiologist. I graduated with a first-class honours from Ulster University in 2020. Following my graduation, I began my career as a qualified Physiologist at South West Acute Hospital (SWAH) in Enniskillen, Co. Fermanagh, where I worked for over three years. During this time, I successfully completed the ARTP practitioner examination in December 2022, achieving a distinction. Completing this exam provided me with a strong foundation of both the theory and practical aspects of lung function testing, which has greatly enhanced my expertise and contributed to my success today. During my time at home, I had the privilege of working with an amazing team of Respiratory and Sleep Physiologists who have played a key role in my achievements and growth, both personally and professionally. I would not be where I am today without them.

It has always been my dream to travel and experience living and working in Australia and from this, I made the decision to adventure to Sydney in December 2023. Making this decision was not easy but being in my twenties, I knew this was the best time to take the chance and take on new challenges and I am incredibly grateful that I did! I am now currently working as a Respiratory Scientist in a highly established hospital called Concord Repatriation General Hospital. I first started in a casual position when I moved to Sydney, working full-time between Respiratory and Sleep services in both Concord and Royal Prince Alfred Hospital before securing a permanent position in Concord. Once again, I feel very fortunate to be part of another fantastic, supportive team. I've learned so much from their knowledge and experience and they have further shaped me into the Physiologist I am today.

To learn more about Eva's career path we have performed an interview to explore her journey and choices

1. What made you decide to move to Australia and continue your career there?

I have always wanted to travel, step out of my comfort zone and grow on a personal and professional level. Australia is known for its robust healthcare system and resources for professional training and clinical research. Moving to Australia has given me the opportunity to share my expertise in a new environment, develop my own knowledge and skills and work towards my professional goals. I have learned so much from the knowledge and experience of my colleagues and have gained amazing experience in a vast range of diagnostic tests. I am extremely grateful, and I intend to carry this level of expertise with me. My long-term goal is to apply this back home, where I can introduce new tests to the services offered in Northern Ireland.

2. Can you walk us through the process of relocating to Australia, including how you set about finding a job and ensuring your qualifications were recognised?

The first thing was applying for a Working Holiday Visa. This visa allows you to stay in Australia for three years on a British passport, with re-applications each year. Thankfully, my visa was granted immediately. Next up on the agenda was booking flights and arranging accommodation for when I arrived. Before leaving, I interviewed for the casual position and was fortunate to be offered the job. This meant I

could start working shortly after arriving in Sydney. I was lucky to hear about the job through my good friend and colleague, Caoimhe Tierney, who was already working in Concord at the time. For anyone searching independently, job opportunities in Australia are regularly advertised on SEEK. One key piece of advice I would give to anyone planning to move is to complete the qualification assessment process to have your degree recognised before arriving in Australia. This assessment compares your degree to the Australian Qualifications Framework (AQF) and can take up to three months to complete which is something I wasn't aware of at the time.

3. Was it important to obtain your ARTP Practitioner Qualification before beginning your relocation?

Absolutely! I would highly recommend this qualification to any Respiratory Physiologist. In Australia, routine PFTs typically include full PFTs (spiro, diffusion capacity and lung volumes) with bronchodilator reversibility, all of which are covered in-depth in this qualification. Lung volume testing is performed a lot more frequently in comparison to back home. Completing this qualification not only enhanced my practical skills in PFTs but also developed my knowledge of the underlying theory and principles behind each of the tests. The combination of this exam and clinical experience has played a significant role in my professional development.

4. Is your role similar to the role of a Respiratory and Sleep Physiologist in Northern Ireland? If not, how does it differ? Have you come across any new treatments or technology in Australia that weren't as common back in Northern Ireland?

Overall, our responsibilities are very similar. The main difference is that PFTs in Australia tend to be more comprehensive mainly due to the greater availability of resources which gives us the ability to perform a wider range of tests. Since relocating, I've gained significant experience in a wide range of respiratory and sleep assessments. I have developed skills in full polysomnography analysis (using Compumedics), CPAP titration (my first exposure to working in an in-lab sleep setting), arterial blood gas sampling, hypoxic challenge testing, shunt studies, forced oscillation technique (FOT) using Resmon PRO and Eucapnic Voluntary Hyperpnea (EVH) testing using EucapSys - SMTEC. FOT, EVH and ABGs are tests, which I had not previously encountered and are now part of my daily routine within the respiratory lab. We also routinely check haemoglobin levels using a HemoCue which is a machine that I didn't have access to back home (although this device may have now been introduced). I work with both Jaeger Masterscreen and Vyntus BODY (Sentry Suite software) and MedGraphics systems (Breeze and Ascent software), all of which are also commonly used in Northern Ireland.

5. How would you say the healthcare systems in Northern Ireland and Australia differ, especially when it comes to treating sleep and respiratory conditions?

As mentioned, the healthcare system in Australia is more advanced than the NHS in terms of resources through increased funding and workforce. Healthcare and treatment are not publicly funded in Australia. Medicare (Australia's universal healthcare scheme) covers free or assisted access to healthcare. For example, Medicare will cover the entire assessment performed in a public lung function lab, however, this is not the case in the majority of private practices and patients will have out-of-pocket costs. Private practice is very common in Australia in comparison to back home, with the majority of Australians having private health insurance.

A major difference in what I noticed is waiting times for testing. At home, there are significantly long waiting times for tests categorised as routine in comparison to Australia. Telehealth is also more common in Australia. For example, virtual spirometry testing is used in weekly cystic fibrosis clinics. Over-the-counter availability is another difference. For example, Ventolin can be purchased over the counter whereas this inhaler requires a prescription back home. Recruitment of staff is also less challenging in Australia due to the availability of funding. Ultimately, the

differences between the healthcare systems comes down to funding.

6. How did you navigate the cultural differences in communication with both patients and colleagues when you moved to Australia?

Working with equality, respect and adapting my communication style has helped to effectively navigate cultural differences. I make a conscious effort to simplify medical terms and use visual demonstrations while cooperating with patients, e.g., when demonstrating the techniques required for PFTs. I always take the time to ensure all patients understand and comprehend any information provided. Working within a culturally diverse workplace is a great experience and has given me the opportunity to learn so much about different cultural traditions and values. Patients and colleagues are also always intrigued by the Irish accent and love to hear about our culture!

7. How have you found the professional support network and community for Respiratory and Sleep Physiologists in Australia? And how has this compared to what you experienced in Northern Ireland?

ANZSRS is the professional body in Australia much like ARTP who supports staff working in lung function labs by implementing best clinical practice and providing opportunities for professional development. They offer a wide range of educational events throughout the year as well as regular branch meetings which bring members together. I had the privilege of attending the TSANZSRS annual conference this year, which was an amazing experience. It was highly informative and I took away valuable tips from a range of professionals in the field. In the past, I have also attended a range of ARTP educational events which have also been fantastic and very informative. I hope one day to also attend the ARTP conference in person. There is a great community of Physiologists, working together and sharing knowledge in both Australia and Northern Ireland. We are fortunate to have amazing teams back home working throughout different trusts. Throughout my career, I've been very lucky to have a strong professional support network from my colleagues.

8. Both personally and professionally, what are some of the biggest challenges you have faced with your relocation?

Unfortunately, relocating and starting a new job across the world isn't always sunshine and rainbows and it does come with challenges. Initially, I found it difficult to maintain a good work-life balance, as I was taking on new work responsibilities while also trying to travel and explore new places. Adapting to new policies, testing procedures and understanding how the multidisciplinary system operates was a bit challenging at first. I was also quite apprehensive initially as I was working across multiple departments within both respiratory and sleep (two hospitals within the same district) and therefore, I was balancing and adapting to a variety of different policies and procedures. However, this was a good experience for me to encounter as I was exposed to a wide range of tests and equipment which has significantly developed my clinical skills. I consider myself highly adaptable, and feel I was able to adjust relatively quickly. Navigating the financial aspects and learning the different billing codes specific to each test took some time. On a personal level, adjusting to a new time zone and coping with homesickness was initially challenging, but I remind myself missing home is completely normal. Overall, while the experience has been quite overwhelming at times with feeling apprehensive, facing these challenges has given me a broader perspective on life.

9. Any advice you would give to any UK Respiratory and Sleep Physiologists considering making the same move to a career in Australia?

Go for it! It is an experience that will help you grow both as a professional and on a personal level. You will gain experience like never before and make friendships that will last a lifetime. If you would like any advice on your big move, please feel free to contact me. I would be more than happy to help!

PROFESSIONAL

What do the OSA Consortium and OSA Alliance actually do?

Professor Brendan Cooper
Consultant Clinical Scientist (on behalf of ARTP SAC), Queen Elizabeth Hospital, Birmingham

The ARTP Sleep Apnoea Consortium (SAC) is a hybrid group currently run and hosted by ARTP, and is a collective of respiratory & sleep professionals, OSA related patient groups and manufacturers whose aim is principally to set technical standards for sleep apnoea services (both diagnostic and treatment) and work with all partners to improve OSA services in the UK. The ARTP SAC Standards are available on the ARTP website [Sleep Apnoea Consortium] and relate to diagnostic services, CPAP treatment and Mandibular Repositioning Device (MRD) treatment standards.

The ARTP SAC was established in June 2008 and held its first meeting at John Stradling's department Sleep Unit, Churchill Hospital, Headington, Oxford. It originated out of the BTS SAC which itself was formed in 2004 which acted as the host organisation for professional bodies, sleep diagnostics and therapeutics manufacturers, patient groups and other related organisations who were "stakeholders" in sleep apnoea. In 2007 BTS re-organised its structure to form Advisory Groups, so ARTP continued the SAC functions in its original format.

ARTP SAC is funded by the manufacturers who join the group, so that funding is available to enable projects and actions to be undertaken without bias or influence for the good of patients.

More recently ARTP SAC has set up independent standards for CPAP devices which allows new CPAP devices from manufacturers to be tested independently by Prof Tomas Netzel at the University of Hamburg. Devices which achieve the ARTP SAC standards appear on the ARTP website [CPAP Device Certification] so that commissioners and sleep departments can see which devices they should be purchasing and recommending.

The ARTP SAC usually meets twice a year (once at conference and once virtually 6 months apart) and discusses all relevant topics in OSA. This has included topics such as recent problems with CPAP devices, CPAP supply chain, DVLA and driving by patients with OSA and many other topics which crop up throughout each year.

ARTP representation on SAC has included representatives from ARTP Education Committee, ARTP Sleep, ARTP Manufacturer's Liaison Committee and ARTP Executive Board. However the strength of ARTP SAC is that it is inclusive and includes all the relevant stakeholders including British Thoracic Society (BTS), British Sleep Society (BSS), Royal College of Physicians of London (RCP Lon), The Royal College of Physicians of Edinburgh (RCP Edin), Royal Society of Medicine (Sleep Section) RSM, British Paediatric Respiratory Society (BPRS), Association of Respiratory Nurse Specialists, Association of Chartered Physiotherapists in Respiratory Care (ACPRC) and General Practitioners in Airways Group (GPIAG).

Perhaps most importantly the ARTP SAC has the Sleep Apnoea Trust Association (SATA) as its main patient group and indeed supports SATA in publishing advice leaflets for patients.

By setting technical standards for OSA, ARTP SAC has a unique role globally in validating independently the performance of current CPAP

machines. It is soon to embark on standards to independently test sleep apnoea diagnostic devices thus providing a current list of checked devices – a project which may take several years to complete.

In about 2018 ARTP SAC joined forces with the OSA Alliance when the DVLA started to change the content of SLC forms used to register OSA patients with DVLA. DVLA inadvertently altered wording which had a major impact on drivers with OSA, so through a series of lobbying meetings we started to get engagement and change with DVLA on this issue. Indeed, the group was initially called the DVLA OSA Alliance because of this. So who or what is the OSA Alliance?

OSA Alliance

The OSA Alliance is predominantly a lobbying body for OSA professionals to challenge and link with government (NHSE, NHS Scotland, NHS Wales & NHS Northern Ireland) and other key stakeholders like NICE, OSA Partnership Group, professional bodies (AHCS, BSS, BTS, ARTP, etc.) and patient groups like SATA. There is some overlap with ARTP SAC, but ARTP SAC links directly with manufacturers and suppliers of OSA equipment (both diagnostic & therapeutic).

In its own words; *OSA Alliance's role is to facilitate collaboration between experts across UK patient and professional sleep organisations. Its remit focuses specifically on obstructive sleep apnoea, where a united approach can facilitate excellence in OSA-related care, education and resource.* The OSA Alliance therefore is an umbrella organisation to facilitate collaboration between experts across UK patient and professional sleep organisations.

The OSA Alliance's website OSA Alliance | Facilitating clinical excellence with all in OSA is a good source of links and resources for all involved with OSA including professionals and patients.

Final Words

ARTP SAC recently had discussions with OSA Alliance about a possible merger, but it was mutually agreed that we have different functions and activities which would not benefit from such a merger. However, the two organisations remain in close contact and regularly discuss common areas of concern and interest.

These two entities have similar but complimentary roles and act to improve OSA services on behalf of all stakeholders. They perform influential roles in enabling change in OSA treatments and informing stakeholders of issues and problems likely to affect patients and providers.

SCIENTIFIC

Non-invasive ventilation and weight management in the treatment of obesity hypoventilation syndrome: A case study

Henry Hodgkins
Trainee Clinical Scientist, University Hospitals of Coventry and Warwickshire

Background

Obesity is a global health problem which affects approximately 27% of adults in England and has a strong association with respiratory and sleep disorders such as obstructive sleep apnoea (OSA) (NICE 2023; Garvey et al., 2015; Dong et al., 2020; Erridge et al., 2021). Some patients such as those with Chronic obstructive pulmonary disease (COPD) or a raised Body mass index (BMI), who exhibit obstructive or restrictive pulmonary defects, may experience chronic nocturnal hypoxaemia (SpO_2 <90%). A BMI >30kg/m^2 with no underlying lung pathology could be classified as having obesity hypoventilation syndrome (OHS), if a reduction in baseline oxygen saturations is observed alongside a raised pCO_2 (>6kPa), in tandem with severe OSA (Shah et al., 2021).

Nocturnal hypoxaemia is resultant of alveolar hypoventilation, impairment to respiratory mechanics; such as impaired mechanical efficiency of the diaphragm caused by displacement by central adiposity, increased upper airways resistance, and reduced ventilatory drive resultant from a blunted central response to hypercapnia (Piper and Grunstein, 2012; Shetty and Parthasarathy, 2015). Leptin resistance has been associated with a reduction in respiratory drive, and leptin secretion is directly correlated with body mass, particularly adipose tissue (Figure 1). It is suggested that chronically elevated leptin levels can lead to inefficient transport of leptin into the brain. Additionally, in mice with leptin resistance, leptin replacement has been shown to be a respiratory stimulant, increasing ventilation in response to hypoxia and hypercapnia (Piper and Grunstein, 2012; Mendoza-Herrera et al., 2021).

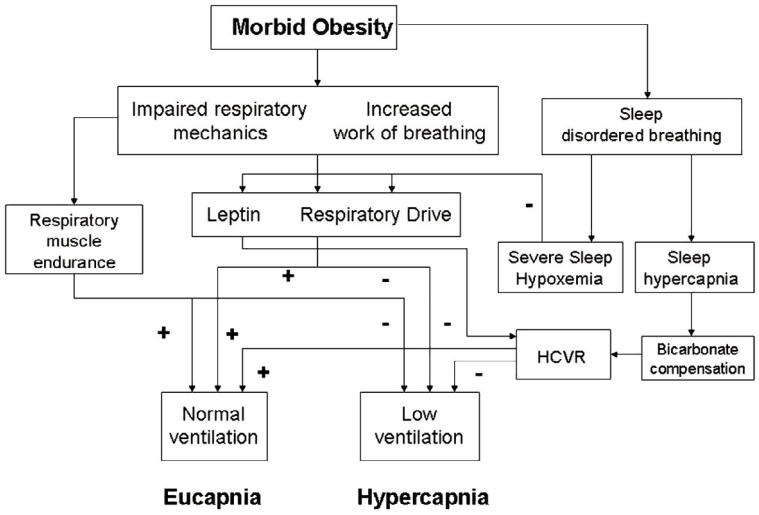


Figure 1: Adapted from Piper and Grunstein (2012). An outline of interactions between factors which contribute to hypercapnia in severely obese patients.

OHS is said to affect approximately 0.4% of the adult population and is typically diagnosed following admissions for acute-on-chronic respiratory failure (Masa et al., 2019). The first

line treatments are the use of positive airway pressure (PAP) in the form of continuous PAP (CPAP), and non-invasive ventilation (NIV), which will often be initiated following an acute exacerbation (Masa et al., 2019; Nuralieva et al., 2024). CPAP, ideally auto-titrating to improve patient-machine synchronicity, is preferred in severe OSA; however, NIV is preferred if the patient is hospitalised due to acute on chronic type 2 respiratory failure. Beyond treatment, weight management improves symptoms of both OHS and OSA, but also improves cardiovascular symptoms, which can be achieved through lifestyle changes, and in more severe cases, bariatric surgery (Nuralieva et al., 2024).

Case Presentation

A 47 year-old female was seen in the NIV clinic following an admission in February 2018 where she had presented with a 3-month history of increasing shortness of breath, 5 days of leg swelling, and two days of pleuritic pain. She had a history of obesity (1.67m, 156kg, BMI 58.7kg.m^2), hypothyroidism, posterior tibial deep vein thrombosis and pulmonary embolism (PE), and complained of chronic fatigue, snoring and a nocturnal wheeze. She was treated with anticoagulation therapy for PE, and had an overnight oximetry performed. She was referred to be followed up in the sleep and ventilation departments, and weight management clinics. Upon discharge she was commenced on 0.5L.min^{-1} long-term oxygen therapy (LTOT), and 2L.min^{-1} nocturnal oxygen on NIV with an initial diagnosis of severe OSAHS.

Investigations and treatment

Baseline overnight oximetry (Figure 2) was consistent with severe OSA (ODI>30dips/hour), with evidence of nocturnal hypoxemia (total study time <90% SpO_2 >25%), and hypoventilation, with an oxygen desaturation index (ODI) of 70 dips.hour, mean SpO_2 of 62% with no study time above 90% saturation. The exceedingly low SpO2 may be explained by her previous PE. She reported an Epworth Sleepiness Score (ESS) of 21, indicating excessive daytime somnolence. Blood tests (Table 1) show evidence of polycythaemia, likely resultant of chronic nocturnal hypoxaemia, with capillary blood gases (CBG) (Figure 3) indicating metabolically compensated type 2 respiratory failure (T2RF). Echocardiography was performed

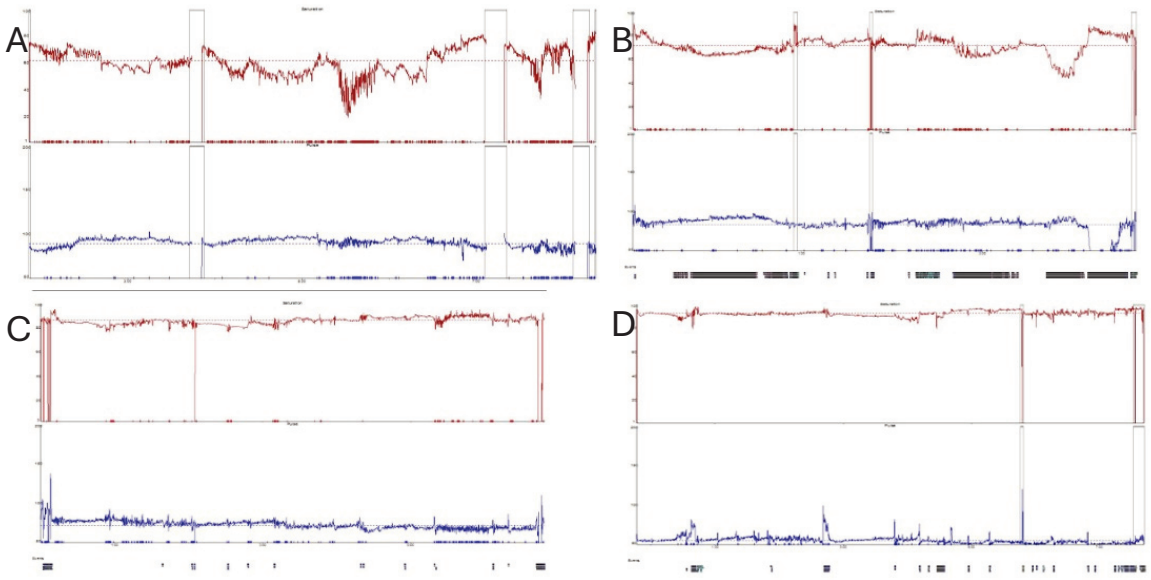


Figure 2: A. Baseline overnight oximetry performed in December 2017 on room air (ODI 70/hr, Mean SpO2 62%, Mean HR 89bpm). B. Repeat overnight oximetry in March 2018 performed on NIV (IPAP 22cmH2O, EPAP 10cmH2O, BR 14bpm; ODI 23, Mean SpO2 72%, Mean HR 83bpm). C. Repeat oximetry performed in March 2018 on NIV (IPAP 24cmH2O, EPAP 10cmH2O, BR 14bpm, O2 2L.min; ODI 11, Mean SpO2 86%, Mean HR 71bpm). D. Repeat overnight oximetry in July 2019 on room air (ODI 5, Mean SpO2 93%, Mean HR 55bpm).

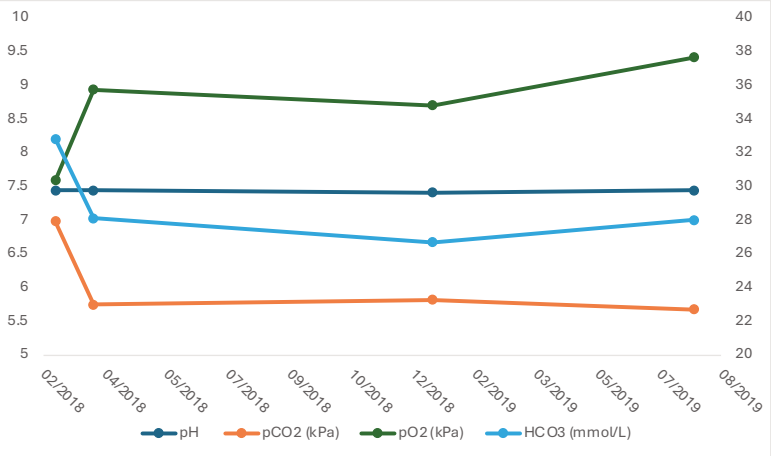


Figure 3: Blood gas pH, pO2 and pCO2 results from NIV clinics.

however the results were inconclusive due to poor image quality.

As the patient had a BMI >30kg.m^2 with no underlying lung pathology (Figure 4), she was diagnosed with severe OSA/OHS overlap, which was confirmed by a capillary blood gas (Figure 3) with a pCO_2 6.98kPa, indicating daytime hypercapnia. Nocturnal transcutaneous CO_2 monitoring was not available at the time of referral which would often be required for formal confirmation of nocturnal hypercapnia in the diagnosis of OHS. However, confirmation of daytime hypercapnia, evidence of hypoventilation through overnight oximetry, a raised bicarbonate on CBG, and a raised BMI >30kg.m^2 provides sufficient evidence for a diagnosis. Capillary blood gas measurement performed in the ventilation clinic confirmed the patient was still in T2RF secondary to suspected OHS which was treated with NIV with the following settings; Inspiratory pressure (IPAP) 22cmH_2O, Expiratory pressure (EPAP) 10 cmH_2O, Back-up rate 14bpm.

Table 1: Key blood markers from prior to admission, and following discharge from the ventilation service.

Date	Hb. (g.L)	Total Cholesterol (mmol.L)	B12 (ng.L)	TSH (mU.L)	Vit D (nmol.L)	HbA1c (mmol.mol)
30/10/2017	164	4.3	380	2.88	41	46
26/01/2021	150	4	412	0.11	25	37

When attending clinic in March 2018, compliance was excellent with usage on 9/10 days for 8 hours a night, with AHI being controlled at 2.6 events per hour. Repeat oximetry was performed on NIV which still indicated moderate OSA (ODI: 23 dips.hr), saturations had improved from 62% to 72%, IPAP was subsequently increased to 24cmH_2O to improve the therapy, and 2L.min^{-1} supplemental oxygen was added to improve nocturnal hypoxia. A further repeat oximetry showed mild OSA (ODI 10 dips.hr) with saturations improving to 86%. A CBG confirmed she was no longer in T2RF with pCO_2, and SaO_2 within normal limits (Figure 3) with pO_2 acceptable for a patient on oxygen therapy (>8kPa) and bicarbonate just above the upper limit of normal (>27mmol.L^{-1}). The increased pressure led to some abdominal discomfort and bloating, however as her compliance was excellent and the therapy was effectively correcting her apnoeas and hypoventilation, no changes were made to improve comfort.

Pulmonary function tests were performed in April 2018 to rule out any pulmonary impairment (Figure 4). Spirometry showed a restrictive pattern with reductions in FVC and FEV_1 below the lower limit of normal and a preserved FEV_1/FVC ratio. Lung volumes and gas transfer were within the limits of normal, however KCO was not corrected for Hb. As the patient is polycythaemic due to chronic hypoxia, KCO may be artificially raised, in turn raising DLCOunc. HRCT further eliminated any evidence of residual pulmonary vascular disease from the previous PE.

Over the following 8 months, the patient achieved significant weight loss, reducing from 120.8kg in January of 2019 at which point pCO_2 on air was normal, and bicarbonate was within normal limits, to 107.6kg by August 2019, with CBG results within normal limits bar bicarbonate

	Pred	Actual	% Pred	LLN	ULN	#SD
SPIROMETRY						
FEV 1 (L)	2.73	1.68	61	2.15	3.31	-2.99
FVC (L)	3.38	2.31	68	2.64	4.12	-2.38
FEV 1/FVC (%)	80.98	72.95	90	70.93	91.03	-1.32
FEF Max (L/sec)	6.25	5.62	89	4.77	7.73	-0.70
FEF 25-75% (L/sec)	2.77	1.15	41	1.43	4.11	-2.00
FEV 1/SVC (%)	80.77	68.41	84			
LUNG VOLUMES						
SVC (L)	3.38	2.46	72	2.64	4.12	-2.04
IC (L)	2.14	2.39	111			
TGV (L)	2.63	1.96	74	1.81	3.45	-1.35
RV (Pleth) (L)	1.66	1.89	113	1.08	2.24	0.65
TLC (Pleth) (L)	4.77	4.35	91	3.78	5.76	-0.71
RV/TLC (Pleth) (%)	35	43	123	25	45	1
DIFFUSION						
TLCOunc (mM/min/kPa)	8.00	8.65	108	6.07	9.93	0.56
TLCOcor (mM/min/kPa)	8.00			6.07	9.93	
KCO (mM/min/kPa/L)	1.73	2.05	118	1.40	2.06	1.58
VA (L)	4.77	4.23	88	3.78	5.76	-0.90
BLOOD GASES						
SpO2						

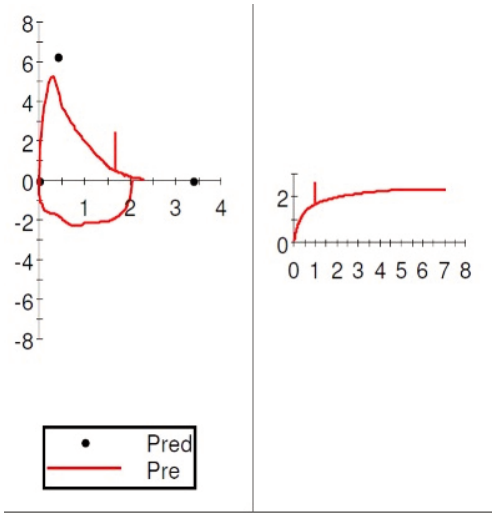


Figure 4 Lung function results

which was above the normal range;; pH 7.44, pCO_2 5.68kPa, pO_2 9.41kPa, SaO_2 95%, HCO^{-3} 28mmol.L^{-1}. She was no longer symptomatic, not experiencing morning headaches or excessive daytime somnolence or shortness of breath.

Overnight oximetry was performed (Figure 2D) indicating a normal ODI of 5 events per hour, mean saturations of 95%, therefore no evidence of hypoventilation, or obstructive sleep apnoea. Furthermore, HbA1c had reduced to normal, non-prediabetic levels, and haemoglobin had reduced towards normal limits. Other blood markers were not outside normal limits upon initial admission, although vitamin D had reduced at the time of the most recent blood test.

Discussion

Patient pathway

The patient presented met the NICE (2021) assessment criteria for OHS, having a BMI >30kg.m^2, and notable features of OSA with witnessed apnoeas, snoring, and excessive daytime somnolence indicated by an ESS of 21. Additionally, she showed features of nocturnal hypoventilation, including waking headaches, peripheral oedema, and unexplained polycythaemia (Piper and Grunstein, 2012; De Terreros et al., 2020; Table 1). CBG indicated that pCO_2 was at the upper limit of 7.0kPa (6.98kPa) for rapid assessment by the sleep and ventilation service, with evidence of severe daytime hypercapnia and hypoxemia (SaO_2 <94%), in addition to acute respiratory failure (Figure 3). Furthermore, as saturations were under 88% for greater than a third of the night, nocturnal oxygen therapy was also supported (McDonald et al., 2016). She did not have any confirmed unstable CVD, or optic neuropathy, and was not under review as a pre-operative assessment (NICE, 2021). Appropriately, she was treated with NIV as suggested for patients who are acutely unwell, rather than trialling on CPAP treatment for patients who present in outpatient clinic which would otherwise be the preferred treatment pathway for OHS (De Terreros et al., 2020; Mokhlesi et al., 2020; NICE, 2021).

Whilst the quality and certainty surrounding evidence for treatment of OHS is low, this patient was reviewed and treated in line with the NICE (2021) guidelines, including 12 monthly follow ups in clinic, with blood gases and repeat oximetry performed as necessary (McDonald et al., 2016). The patient was able to lose weight without the assistance of the hospital's weight management clinic and her treatment was appropriately adjusted along the course of her weight loss. When the patient was no longer symptomatic,

repeat oximetry was performed to confirm there was no remaining evidence of OSA or hypoventilation, and she was discharged from the service appropriately.

Investigations

Oximetry is suitable for use in patients with a BMI >30kg.m^2 in place of multi-channel polysomnography, or where access to multichannel home polygraphy is limited or unavailable. NICE suggest that oximetry can be inaccurate in differentiating between people with sleep disordered breathing, and other causes of hypoxemia such as people with heart failure or COPD, as these patients may experience Cheyne-stokes respiration, or hypoventilation without evidence of obstructive events. Multichannel polysomnography is required for diagnosis of these conditions as respiratory effort and flow are required, or for mild cases of SBD as overnight oximetry lacks the sensitivity and specificity to diagnose and differentiate outside of moderate to severe OSA (Singh et al., 2020; NICE, 2021).

NICE currently does not have guidance on the diagnostic assessment of OHS, rather just specificity and sensitivity of OSAHS diagnosis by use of oximetry and multichannel studies. They reiterate that OHS is characterised by a raised serum bicarbonate, obesity and daytime hypercapnia (Piper and Grunstein, 2012; Shetty and Parthasarathy, 2015; De Terreros et al., 2020; NICE, 2021; Grassion et al., 2023). It is recommended to perform transcutaneous CO_2 monitoring to establish the extent of nocturnal hypoventilation. Markedly raised CO_2 would indicate NIV treatment over CPAP treatment. (Soghier et al., 2019; NICE, 2021; Grassion et al., 2023).

The patient had full pulmonary function testing performed (Figure 4) to rule out any pulmonary involvement, confirming restrictive spirometry without significant loss of total volume. The raised RV could be attributed to central adiposity, further contributing to diaphragmatic impairment during sleep (Piper and Grunstein, 2012; Masa et al., 2019; Nuralieva et al., 2024).

A review by De Terreros et al. (2020) found very low levels of certainty in all evidence used to support the diagnosis and treatment of OHS, suggesting that significantly more research is required in the area to improve and enhance treatment pathways and outcomes before they manifest as more severe cardiovascular disease.

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SCIENTIFIC

Implications of obesity and changes in body weight on sleep disordered breathing: A case report

Ryan Pettifer
Trainee Clinical Scientist, University Hospitals of Coventry and Warwickshire

Overview
Obesity affects many physiological processes including sleep and respiration and is a significant risk-factor for obstructive sleep apnoea (OSA) and obesity hypoventilation syndrome (OHS). The purpose of this case study was to highlight the impact that obesity and weight change can have on sleep disordered breathing (SDB). A case is presented of a 39-year-old woman who initially demonstrated Mild OSA. Her OSA increased in severity with the onset of OHS and pulmonary restriction following weight gain. After receiving bariatric surgery, she lost weight and her pulmonary restriction and OHS appeared to resolve. Two years later, maintaining her weight, she demonstrated Severe OSA and OHS again. This case discusses the implications by which weight-loss can improve respiratory mechanics and how being in an energy deficit whilst losing weight may improve respiratory drive.

Background

Obesity is characterised by the accumulation of excess adipose tissue and is defined by a body mass index (BMI) of ≥30kg/m^2 (World Health Organization, 2000). Longitudinal studies estimate that 29.3% of men and 31.3% of women in the UK were obese in 2016, with peak obesity prevalence of 37% projected to occur between 2035-2040 (Janssen, et al., 2020).

OSA is characterised by intermittent collapse of the upper airway during sleep (Figure 1) (McNicholas and Pevernagie 2022). UK OSA prevalence rates are reported to be 5.4% and are expected to increase in line with obesity prevalence, however, it is estimated that up to 80% of patients with OSA are yet to be diagnosed (Erridge et al., 2021).

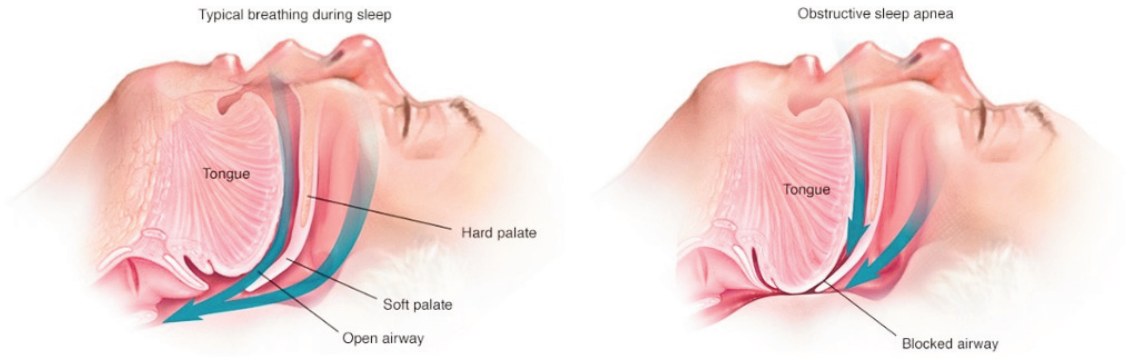


Figure 1. Schematic representation of OSA adapted from Mayo Clinic (2024). Fat deposition in the tongue and the surrounding tissue in the upper airways contributes to a smaller airway lumen and increases collapsibility, predisposing individuals to apnoea during deep sleep following the loss of pharyngeal dilator muscle tone (Romero-Corral et al., 2010).

Elevated BMI is a significant risk-factor for OSA (Chan et al., 2019). One study found that a 10% increase in weight predicted an approximate 32% increase in apnoea-hypopnea index (AHI), a measure of OSA severity. Whereas a weight-loss of 10% predicted a reduction in AHI of 26%, indicating a strong causative relationship between body weight and OSA (Peppard et al., 2000).

OHS classically involves alveolar hypoventilation, accompanied by obesity, with daytime hypercapnia (pCO_2 >6.0kPa) (Mokhlesi et al., 2019). Whilst OHS only affects ~0.4% of the adult population, the incidence of OHS is reported to be as high as 48% in individuals with a BMI >50kg/m^2 (Masa et al., 2019; Nowbar et al., 2004). OSA is present in 90% of patients with OHS (Mokhlesi and Tulaimat 2007; Olson and Zwillich 2005). Higher BMI, AHI, greater neck circumference and lower FEV_1 have been associated with the occurrence of OHS in patients with OSA, indicating that OSA may progress onto OHS in patients with greater obesity burden (Liu et al., 2017).

Obesity causes changes to respiratory mechanics and respiratory drive in patients with OHS. Mechanistically, excess fat deposition in the abdomen and thoracic region limits chest wall expansion, causing decreased lung compliance, thoracic volume, and basal alveolar ventilation causing inefficient gas exchange and increased work of breathing that results in reduced tidal volumes during sleep (Salome et al., 2012). Patients with OHS exhibit these features and reduced ventilatory response to hypoxia and hypercapnia because of leptin resistance and blunting of chemoreceptor sensitivity due to repeated nighttime hypercapnia (Amorin et al., 2022).

Case presentation

A 39-year-old female with no smoking history was referred to the sleep clinic in July 2016 for a limited channel polygraphy study, with the following indications: BMI of 57kg/m^2 (135kg), Mallampati score II, and snoring with no daytime somnolence. Results indicated mild obstructive sleep apnoea (AHI:5.7/hr), with no evidence of nocturnal hypoxia, hypoventilation, or Cheyne-stokes respiration. The patient was subsequently discharged back to her GP as treatment with CPAP is only recommended for symptomatic patients in mild cases of OSA (Gómez de Terreros et al., 2020).

In March 2020 she was admitted to hospital following a two-day history of increased shortness of breath. Her BMI on admission was 69kg/m^2, on examination her chest was clear. Arterial blood gases reported chronic compensated Type II respiratory failure (Table 1).

Table 1. Blood gas results on room air with normative reference values (Sylvester et al., 2020).

Units	Blood gas results	Normal value
pH	7.42	7.35 – 7.45
pCO_2	6.61kPa	4.8 – 6.0
pO_2	8.44kPa	10.0 – 13.5
HCO_3	30.6mmol/L	22.0 – 26.0
SpO_2	90.4%	95 – 98%

An inpatient overnight oximetry was conducted to investigate the presence of SDB. Results reported severe SDB with an ODI of 76dips/hour and evidence of nocturnal hypoxia with a mean SpO_2 of 81%. The oximetry trace (Figure 2) shows evidence of hypoventilation. Results together with her raised BMI and pCO_2, indicates a diagnosis of Severe OSA/OHS. Spirometry was conducted, demonstrating severe restriction (FVC: 1.62L (Z-score -3.90), FEV_1: 1.62L (Z-score -3.33), FEV_1/FVC: 85.4% (Z-score 0.43)) (Sylvester et al., 2020).

The patient was titrated with domiciliary NIV on spontaneous/timed mode with an inspiratory pressure of 24cmH_2O, an expiratory pressure of 8cmH_2O and a backup rate of 14 breaths per minute, to increase nocturnal tidal volumes aiding in the ventilatory clearance of CO_2. The patient exhibited good synchronisation with their NIV, obtaining tidal volumes of 1000ml with an acceptable mask leak <20L/min. The patient was discharged with domiciliary NIV.

A follow-up in May 2020 demonstrated good NIV compliance, achieving an average daily use of 8 hours 54 minutes. She reported symptom improvement and no morning headaches.

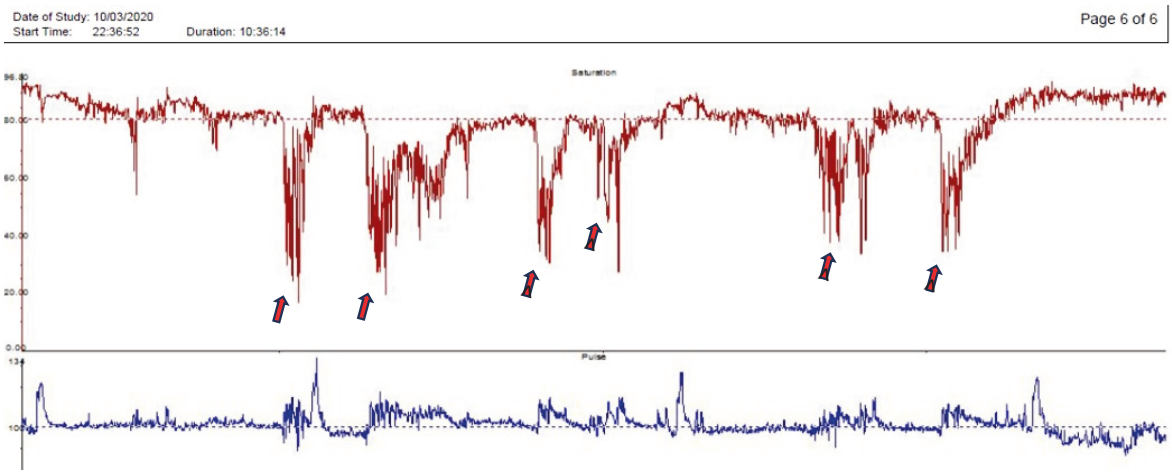
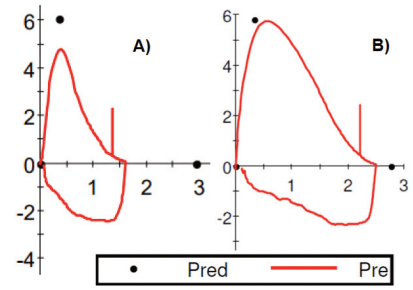


Figure 2. Inpatient overnight Oximetry. SpO2 trace demonstrates a saw-tooth pattern typical of OSA. Red arrows indicate episodes of hypoventilation with progressive desaturation and slow return to baseline SpO2% (Berry et al., 2020).

This patient underwent laparoscopic sleeve gastrectomy (LSG) bariatric surgery in September 2020 in attempts to reduce her obesity burden and improve her SDB. Her weight before surgery was 170kg (BMI:71.6kg/m^2). An NIV review in December 2020 revealed that the patient was not using her NIV. Despite this, she reported that her breathing had improved attributing this to her weight-loss of 25.5kg, with a self-reported weight of 144.5kg. An earlobe capillary blood gas (CBG) demonstrated no evidence of daytime hypercapnia (pCO_2: 5.37kPa) with normal oxygen saturations (SaO_2:96%), however her bicarbonate was still elevated at 30.3mmol/L. Repeat overnight oximetry was conducted in accordance with NICE (2021) Guidelines, ODI was 6.9/hr, with a mean SpO_2 of 92%, Pulse rises of >6bpm were elevated at 58.2/hr, no episodes of hypoventilation were seen. These results were consistent with mild SDB. Her case was discussed at MDT, resulting in NIV discontinuation due to her continued/expected weight-loss and reluctance to utilise NIV.

Pulmonary function tests were conducted 14 months following bariatric surgery with a weight of 143kg demonstrating no further significant weight-loss. Spirometry was within normal limits, lung volumes were approaching the lower limit of normality, thoracic gas volume was moderately reduced. Gas transfer was within normal limits; however alveolar volume was mildly reduced. There was no evidence of lung pathology, with reductions in lung volumes likely being attributed to high BMI. Figure 3 demonstrates the improvement in spirometry following bariatric surgery.



C)

Date of test	BMI (kg/m^2)	FEV1 (L)	FVC (L)
09/03/2020 **(A)**	69.2	1.38	1.62
25/11/2021 **(B)**	63.1	2.24	2.51
Percentage change	**9.6%**	**38.4%**	**35.5%**

Figure 3. A) Inpatient spirometry demonstrating severe restriction. B) Spirometry within normal limits, 1 year after bariatric surgery. C) Table depicting the date that spirometry was performed, with depiction of the corresponding flow volume loop labelled '(A)' or '(B)' and the recorded BMI, FEV1, and FVC values established for each visit.

In February 2023 a limited polygraphy study was conducted, as she was experiencing daytime somnolence with witnessed apnoeas. The sleep study was consistent with severe SDB (AHI 35 events/hour). Average SpO_2 was reduced at 83.6% indicating nocturnal hypoxia, with evidence of hypoventilation seen (Figure 4). A CBG was not performed to confirm the presence of daytime hypercapnia so a further diagnosis of

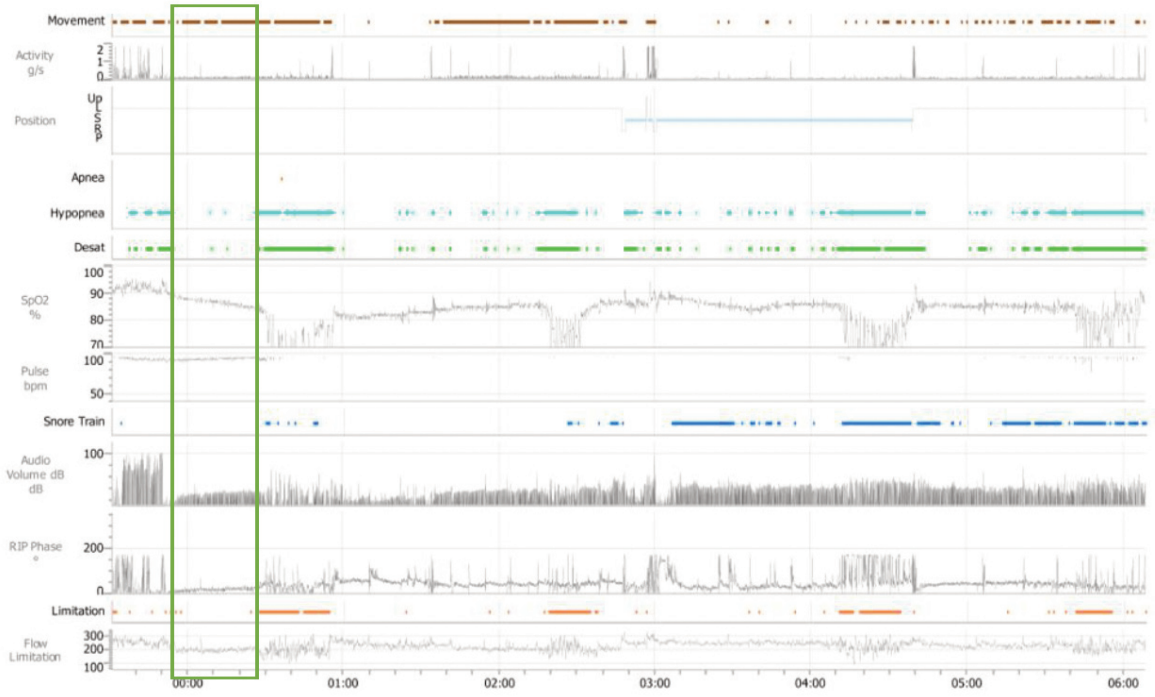


Figure 4. Multichannel sleep study demonstrating reduced oxygen saturations with significant sleep disordered breathing of a predominant hypopneic origin, with periods of hypoventilation, episodes that may be consistent with REM sleep are indicated by red arrows. The area highlighted by the green box depicts progressive desaturation with minimal airflow limitation, snoring, and RIP Phase, consistent with hypoventilation, demonstrating reduced ventilatory response to hypoxia.

OHS could not be confirmed at this time, as per recent NICE (2021) guidelines. As Continuous P ositive Airway Pressure (CPAP) is recommended for stable ambulatory patients with OHS or suspected OHS and severe OSA, the patient agreed to commence therapy on auto-titrating CPAP in November 2023 (Gómez de Terreros et al., 2020).

Discussion

This patient presented with high BMI (57kg/m^2) but only mild OSA (AHI:5.7/hr). Her Mallampati score of II indicates that she could be anatomically resistant to SDB and that perhaps only in severe obesity does it manifest. A recent cross-sectional study demonstrated that 33% of individuals with no OSA on polysomnography had a Mallampati score of II (Nair 2023).

Laparoscopic Sleeve Gastrectomy (LSG) resulted in significant rapid weight-loss, improvements in symptoms, resolution of SDB, and pulmonary restriction. Recorded weight-loss peaked at 27kg and was stable for 2 years, achieving a BMI of 60kg/m^2. Overall, this demonstrated poor efficacy of her LSG despite promising early results of 25.5kg weight-loss in 3 months. Despite only reducing her weight by 27kg (15% bodyweight) and remaining at 60kg/m^2 she presented with normal spirometry 1-year following bariatric surgery. Therefore, her LSG and weight-loss were effective in improving her pulmonary physiology and therefore respiratory mechanics.

Unfortunately, her severe OSA and OHS returned 2-years following LSG, whilst at the same BMI (61kg/m^2) which previously reported only mild OSA. Interestingly, her polygraphy (Figure 4) may indicate the reasons for this. The period outlined (green box) demonstrates progressive desaturation, with minimal flow limitation, and reduced RIP Phase and snoring. Indicating minimal airway resistance with no respiratory arousals from progressive

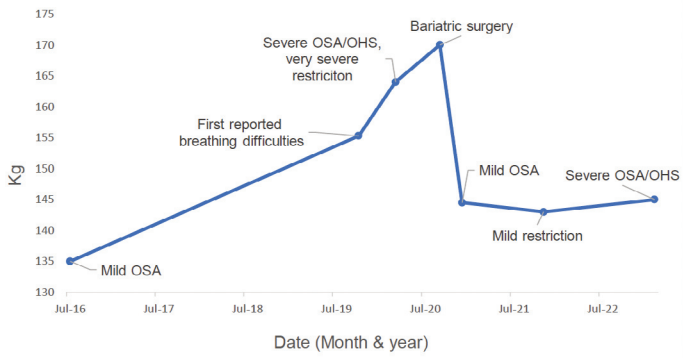


Figure 5. Line graph representing the patient's weight over time with associated clinical events.

desaturation. These features were not seen on her oximetry study following bariatric surgery and rapid weight-loss. Furthermore, there were no indications that her respiratory physiology or weight had changed between her post bariatric surgery oximetry and her polygraphy study 2 years later (Figure 5), which may have explained the significant change in her SDB. Therefore, the changes seen are likely due to changes in respiratory drive and inadequate ventilatory response to hypoxia and hypercapnia. Historically, the effects of obesity on sleep and respiration have been regarded as anatomical and physiological processes, however, there is now growing understanding of how obesity can affect breathing control.

Leptin is a hormone predominantly secreted by adipocytes, its main function serves to regulate appetite. It also aids neural control of breathing, central respiratory drive in response to hypoxia and hypercapnia (Amorin et al., 2022). Classically a minor increase in leptin concentration reduces appetite and has demonstrated reductions in body weight (Gruzdeva et al., 2019). However, in obesity, increased leptin concentration has no effect on weight-loss or appetite, this is termed leptin resistance and is almost a universal feature amongst obese individuals (Gruzdeva et al., 2019). In individuals with OHS, respiratory drive is attenuated because of inadequate ventilatory responses to hypoxia and hypercapnia that are caused due to alveolar hypoventilation (Shah et al., 2021). Leptin resistance and leptin signalling play a critical role in the onset of hypoventilation, through mechanisms affecting both the central and peripheral chemoreceptors as demonstrated in mouse models (Bassi et al., 2012). This is later exacerbated by recurrent nighttime hypercapnia, which further blunts chemoreceptor sensitivity (Greer and Venkateshiah 2020). Elevated serum l eptin levels are suggested to be a better predictor of hypercapnia and OHS than body fat percentage and BMI, with higher leptin levels predisposing individuals to hypoventilation (Phipps et al., 2002).

Mazahreh et al (2019), demonstrated that LSG significantly reduced the leptin resistance index, increasing leptin receptor levels, whilst reducing BMI. Recent evidence has found that leptin signalling is improved following bariatric surgery in obese patients via increased blood-brain barrier permeability (Alosco et al., 2015). Weight-loss through diet, exercise, and LSG is 'sensed' as a negative energy balance resulting in reductions in leptin levels and improvement in leptin signalling (Münzberg et al., 2020; Bassi et al., 2012). Leptin levels are strongly correlated to weight-loss and loss of fat mass following bariatric surgery (Trakhtenbroit et al., 2009; Terra 2013). Whether this correlation relates to the energy deficit induced causing fat loss by the associated 'sensed' negative energy balance that reduces leptin concentration and improves leptin signalling, or whether it is as a direct result of fat loss is as yet unknown (Münzberg et al., 2020). Persistent weight-loss may maintain low leptin levels, increasing leptin sensitivity and re-establishing its hypoxic and hypercapnic ventilatory stimulating properties. There is therefore potential that the patient's oximetry study 3-months post-surgery reported mild OSA due to transient improvements in respiratory drive whilst in an energy deficit, that no longer persisted when in energy homeostasis with obesity, due to the return of leptin resistance.

There are limitations to this theory. Firstly, leptin levels were not recorded at the time of either sleep study and the literature surrounding this topic is in

its infancy. Secondly, the inter-night reliability of oximetry studies is poor. One study found high night-to-night variability of ODI in patients with OSA (n=197). Demonstrating a coefficient of variation of 31.1%. >10/hr ODI between nights were observed in 84.4% of patients changing the severity classification in 77.9% of these patients (Fitze et al., 2004). Therefore, the post-bariatric surgery oximetry may have underestimated this patient's SDB. Additionally, pulse rises of >6bpm were found to be 58.2/hr, which could indicate obstructive apnoeas that did not cause desaturations. Ideally a limited polygraphy study should have been conducted following the elevations in pulse rises to ascertain if they were because of respiratory-related arousals following apnoeas. The AASM do not recommend the use of oximetry for the diagnosis or monitoring of OSA, at a minimum they recommend a limited polygraphy study (Rosen et al., 2018; Kapur et al., 2017).

Conclusion

This case report demonstrates the impact of weight on OSA/OHS. The patient initially exhibited a classical progression of OSA associated with weight gain which progressed onto OHS. She was correctly treated with NIV and later underwent bariatric surgery, resulting in weight-loss and almost full resolution of her SDB. However, at the same weight, with no evidence of additional respiratory impairment, her SDB increased in severity with her polygraphy demonstrating hypoventilation. This suggests only temporary benefits from LSG whilst the patient was losing weight. Following weight maintenance, her respiratory drive in response to hypoxia and hypercapnia reduced. Suggesting a potential pathogenic role of obesity whilst in energy homeostasis. Elucidating the mechanisms by which energy homeostasis in obesity and/or an energy deficit may impact respiratory drive may yield promising therapeutic targets. It seems that weight-loss positively impacts respiratory mechanics and upper airway resistance. However, there may be benefits from being in a state of energy deficit with implications on leptin levels, leptin sensitivity and therefore respiratory drive.

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SCIENTIFIC

Investigating outcome of NICE guideline changes for mild symptomatic OSA patients to receive CPAP

Jennie Crawley, Lois Attewell, Lewys Biggs, Corey Davies
Cardiff and Vale University Health board, Penarth, UK

Introduction
Previously, Obstructive Sleep Apnoea (OSA) patients diagnosed as mild (Apnoea Hypopnea Index (AHI) 5.0-14.9/hr) in the UK were not recommended Continuous Positive Airway Pressure (CPAP) treatment according to National Institute for Health and Care Excellence (NICE) guidelines, regardless of symptoms. In 2021, NICE guidelines changed to recommend CPAP treatment for symptomatic mild OSA patients (e.g. those with excessive daytime somnolence).

Methods

We set out to assess CPAP compliance of mild symptomatic OSA patients given CPAP under this new guidance. We investigated how gender, age, BMI, symptoms at initial consultation, and Epworth Sleepiness score (ESS) related to categorical (>4hrs on 70% nights: 0/1) and continuous compliance (average hours/night). We looked at this over 4 timepoints (2 weeks, 3 months, 6 months and 1 year for 124 patients (458 observations) who had sleep studies performed between January 2021-May 2023.

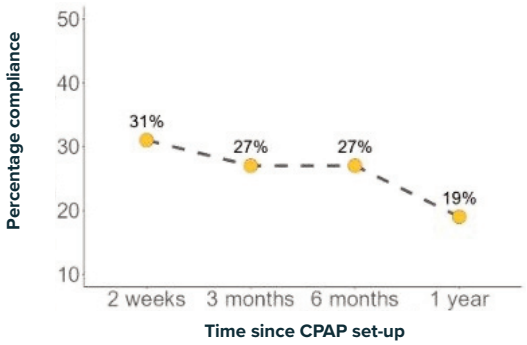

Figure 1. CPAP categorical compliance over time

Results

We found a significant reduction in categorical compliance over time (Figure 1), but not when measuring average hours of CPAP usage. The measures BMI, ESS, and age were not found to significantly influence compliance in our sample of mild symptomatic patients. The number of presenting symptoms at initial consultation correlated with CPAP compliance, but this was gender specific. The number of symptoms at initial consultation were correlated with both categorical compliance and number of hours used in male but not female patients (Figures 2a &b).

Discussion

Our average 3-month CPAP compliance in mild symptomatic OSA patients was 27%; at the lower end but within the 27-51% 3-month compliance found generally in OSA patients across five UK institutions in 2020 (Dielesen et al., 2021).

Compliance declined over the first year of CPAP treatment, reinforcing the importance of early advice and support in mild symptomatic patients, such as mask fit and troubleshooting appointments. This is particularly important as early CPAP usage has been found to predict longer-term compliance (Budhiraja et al., 2007).

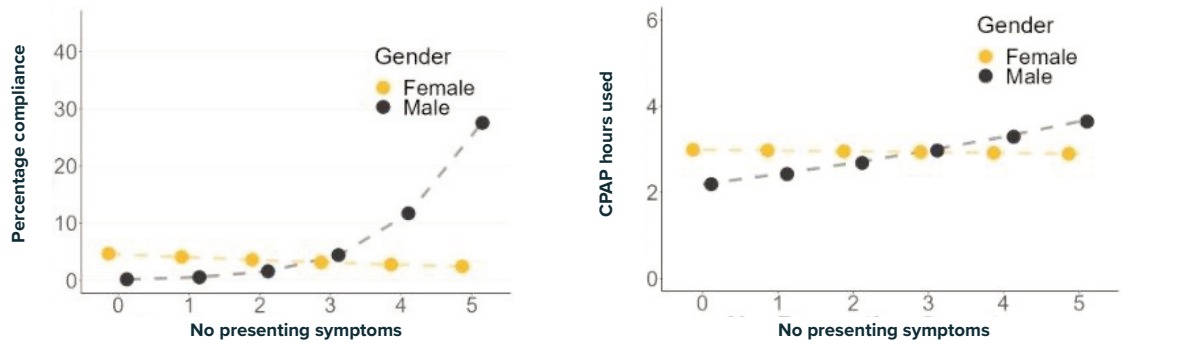

Figure 2. Model predicted a) categorical compliance and b) average CPAP hours used depending on number of presenting symptoms for male and female mild OSA patients

As CPAP treatment for these mild OSA patients is primarily for symptomatic improvement, benefits of treatment should be at the forefront of conversations with patients, aiming to encourage self-management of their treatment.

The number of symptoms at initial consult (snore, morning headaches, witnessed apnoeas, nocturnal choking) predicted compliance in men, but not women. This finding of factors predicting CPAP compliance being gender-specific, is consistent with other studies (Fujita et al., 2022). This could be due to a lot of the 'typical' symptoms often associated with OSA, as used in this study, being male-biased. For example, previous studies have found that the main presenting symptoms in women were more likely to be insomnia, tiredness, and low mood, whilst they were less likely to report snore, witnessed apnoeas, and sleepiness (Yukawa et al., 2009, Shepertycky et al., 2005, Nigro et al., 2018). Therefore, future studies should make sure to include OSA symptoms more typical to women going forward (e.g. tiredness, low mood, insomnia, delayed sleep onset), information which is already gathered during initial consultation appointments in our department.

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RESEARCH AND AUDITS

Evaulating the diagnostic accuracy of smartphone video clips against polysomnography for paediatric obstructive sleep apnoea

Mr. Cal Mclean, Mr. Zachary Jones, Mr. Joseph Eliahoo, Professor Parviz Habibi
Imperial College Healthcare Trust, London, United Kingdom

Introduction

The gold standard of paediatric Obstructive Sleep Apnoea Syndrome (OSAS) diagnosis is overnight polysomnography (PSG). Current validated screening methods for paediatric OSAS are limited. Increasingly, parents present video clips which capture behaviours indicative of OSAS. We aimed to compare the diagnostic accuracy of a standardised sleep video analysis tool (Videosomnography Analysis for Paediatric Sleep apnoea (VAPS)) against PSG for paediatric OSAS.

Methods

111 children, 2-12 years old referred for suspected OSAS underwent In-Lab PSG. Parents recorded 2 one-minute videos of their child's sleep during PSG, and for two nights at home post-PSG. Videos were scored for the presence of 9 behaviours indicative of OSAS. PSG was scored independently and compared to VAPS scores.

Results

Total VAPS score had good discriminatory ability between PSG-diagnosed clinically non-significant (n=63) and clinically significant (n=48) OSAS, with an area under the ROC curve of 81.99%. Scores of ≥3 had a sensitivity of 91.67% and scores of ≥7 had a specificity of 88.89%. The area under the ROC curve rose to 85.45% when parents confirmed they were able to capture their child's worst breathing. For this subset, VAPS score of ≥3 had a sensitivity of 96.43% and scores ≥7 had a specificity of 88.89%.

Conclusions

VAPS score may be useful in triaging patients suspected of paediatric OSAS to the appropriate physiological sleep investigations or treatment options where a Score of ≤2 is considered low risk, 3-6 medium risk, and ≥7 high risk, for paediatric OSAS.

RESEARCH AND AUDITS

Mandibular jaw movement with the Sunrise device – Novel parameters beyond home polygraphy

Ms. Lorna McKay, **Dr Phyllis Murphie**

[1]Quest Clinic, Ayr, Scotland, [2]Sefam Medical Ltd, Dumfries, Scotland

Introduction

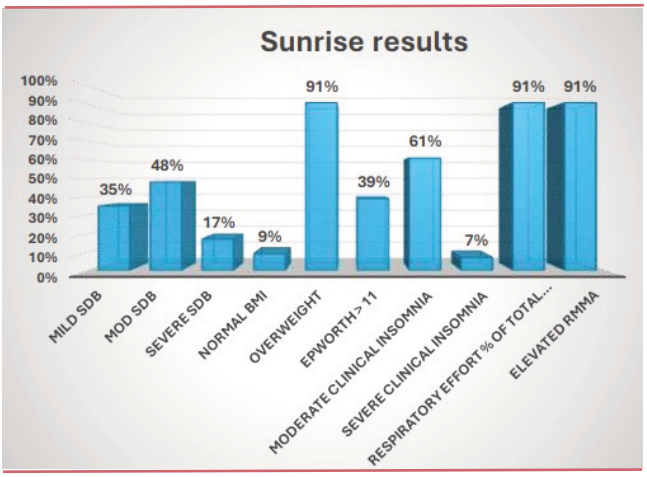
Sunrise is a lightweight, 3-gram CE-marked sensor used during sleep to monitor mandibular jaw movements (MJM), indicative of sleep-disordered breathing (SDB). Worn on the chin (at home), Sunrise provides an artificial intelligence generated report with sleep metrics, including the apnoea-hypopnea index (AHI) (1), body mass index (BMI), Epworth sleepiness scale (ESS), insomnia severity index (ISI), total sleep time (TST), sleep stages, rhythmic masticatory muscle activity (RMMA), and sleep position. A novel metric is the respiratory effort burden, representing the cumulative duration of obstructive events.

Methods

25 adults referred with suspected SDB. Participants underwent a Sunrise test following a review by an Advanced Respiratory Nurse.

Results

25 (18 males, 7 females) completed the Sunrise test. Among these, 65% (18/25) showed moderate to severe SDB, while 88% (22/25) were overweight. An ESS score of 11 or higher was observed in 40% (10/25). Additionally, 68% (17/25) reported possible comorbid insomnia. Elevated RMMA, (bruxism episode index, BEI >4), was seen in 92% (23/25), Respiratory effort burden exceeded 30% of TST in 84% (21/25).



Conclusions

The high prevalence of obesity observed in this series highlights the importance of weight management. Also, the high prevalence of Co-morbid insomnia and excessive Sleep bruxism in this series warrants further investigation. Elevated respiratory effort burden is linked to increased risk of Type 2 diabetes (2) and hypertension (3). This metric is important due to its association with sympathetic overactivity and vascular changes common in sleep apnoea. Sunrise measures parameters beyond standard home polygraphy, providing advanced insights into SDB. By leveraging these insights, sleep medicine clinicians can potentially enhance and apply personalised treatment strategies for individuals with sleep-disordered breathing.

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RESEARCH AND AUDITS

Going MAD: The alternative for CPAP-intolerant OSA patients

Mr. Alex Bigos

University Hospital of Derby and Burton NHS Foundation Trust, United Kingdom

Introduction

Nationally access to Mandibular Advancement splints (MAD's) for treatment of Obstructive Sleep Apnoea (OSA) is inconsistent. Nice guidelines (No. 202.) recommend MAD's for the treatment of OSA as an alternative to Continuous positive Airway Pressure (CPAP). However, access to this treatment varies across the NHS. The aim of this retrospective audit was to determine what proportion of CPAP intolerant patients could be eligible for MAD's in the trust and highlight the potential need for service development.

Methods

Between July and November 2024, 100 patients with a diagnosis of OSA had returned their CPAP machine due to intolerance and had been discharged from the sleep service. A review of these patients OSA severity and eligibility for MAD was conducted using the NICE criteria (No.202). AHI had previously been graded using AASM 2007. Snore was reviewed in the mild OSA group where snore was considered significant if >10% of total breaths per night (Iber et al. AASM Manual for the Scoring and Sleep and Associated Events. 2007).

Results

Of the 100 patients reviewed, 60 were deemed potentially eligible for an MAD trial assuming they had optimal dental and periodontal health. Among these, 49% had severe OSA, 6% had moderate OSA, and 5% had mild OSA with significant snoring. Figure 1 presents a pie chart illustrating the distribution of patients who returned their CPAP devices based on OSA severity.

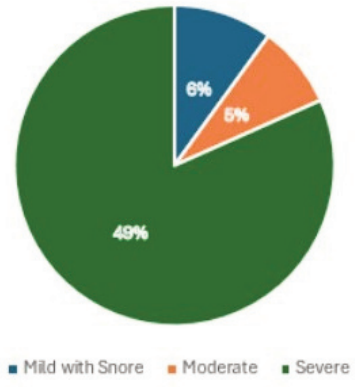

Figure 1. Patients returned/discharged by severity

Conclusion

While CPAP remains the gold standard for treatment of OSA, this audit highlights the potential need for alternative management strategies for the significant amount of patient's intolerant of CPAP (Marklund et al. ERJ 39(5), 1241–1247). To establish formal pathways for MAD therapy, a collaborative approach between the sleep service (CPAP) and the dental team (MAD) is essential.

RESEARCH AND AUDITS

Is it appropriate to perform auto-analysis in home oximetry studies?

Mrs Katie Rutterford, Mr. Peter Muse-Ray
South Tyneside And Sunderland NHS Foundation Trust, Sunderland, United Kingdom

Introduction

In line with recent guidance, home oximetry can be used when access to respiratory polygraphy studies is limited (NICE 2021). The COVID-19 pandemic put pressure onto diagnostic waiting times (NHS 2023), meaning more patients were listed for home oximetry and multi-channel limited polygraphy studies compared with pre-pandemic levels.

As polygraphy analysis can be more time-consuming, it was proposed that using auto-analysis for home oximetry may ease pressures and give physiologists more time for polygraphy analysis.

Aim

Is it appropriate to auto-analyse oxygen desaturation index (ODI) in home oximetry?

Methods

In studies between May and August 2024, the automated ODI on download and the ODI after manual analysis were recorded on Microsoft Excel. Scoring of events was measured as ≥4% dip in %SpO_2 using Masimo Rad-97 oximeters (Visi-Download - Stowood Scientific Instruments Ltd). A paired t-test assessed for any statistical difference between auto- and manual-analysed ODI, significance was accepted at $p<0.05$.

Results

149 oximetry studies were analysed, ODI >10 was considered as significant for treatment (SIGN 2003). Within the local sleep service, ODI ≥ 15 automatically proceeded to treatment. There was no significant difference between overall auto- and manual-analysed ODI ($p=1.66$).

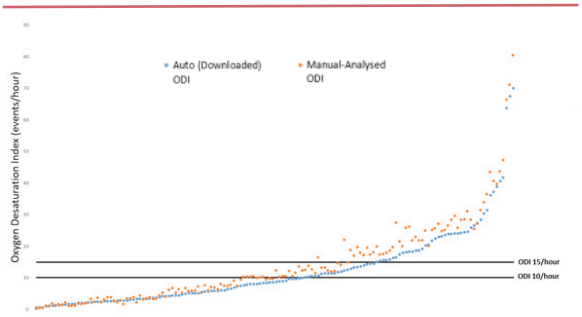

Figure 1. Auto- vs manual-analysis plotted against the y-axis of ODI with 2 solid lines to show the markers of ODI 10 and ODI 15 (events/hour)

Generally, manual analysis increased ODI from the downloaded value. Out of 101 data points where ODI >5 events/hour, 97 saw ODI increase after manual analysis ($\Delta\bar{x}$ 2.01 events/hour). Only 4 saw ODI decrease (<-1 event/hour) which didn't cross any clinically significant boundaries.

Conclusions

As manual analysis tends to increase ODI, auto-analysis of ODI 7-15 would be inappropriate due to proximity to clinically significant thresholds. Using auto-analysis outside of those ranges is appropriate due to negligible changes that wouldn't affect onward treatment. Using auto-analysis when appropriate will allow physiologists more time for analysing polygraphy studies.

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RESEARCH AND AUDITS

Audit of home sleep study failure rate compared to full polysomnography

Prof Brendan Cooper, Alison Butler, Mr. Richard Glover, Mrs Jodie Hunt, Mrs Theresa Cunnington, Dr James Stockley, Miss Laura Smith, Mindi Daniels, Dr Julie Lloyd

University Hospitals Birmingham, Birmingham, United Kingdom

Introduction

We reviewed the failure rates of 3 commercially available sleep home diagnostic systems as well as oximetry and attended polysomnography to identify key channel failure rates and overall study failure rates. Studies were categorised into (OK) no significant failures, (Partial) partial failures (>1 channels failed for >1 hour but didn't affect the study outcome and (Fail) fully failed causing study outcome.

Methods

We audited 2433 home sleep studies across all sites to determine the failure rates of Embletta (n=385 over 14 months), S-Med (n=100 over 1.5 months), WatchPAT (n=671 over 17 months) and Smed PSG (n=592 over 13 months). Channels included (if available*) oximetry, flow/respiratory, snoring, thorax*, abdomen*, PAT* and body position. Studies with no data collected or a short study (<4hrs) were also included. Fail rates were fails per device.

Results

The technical outcomes are shown in Figure 1 (A-D). Simpler studies with fewer sensors had less fails (Figure 1A) and were similar to the PSG attended studies. Both Embletta and S-Med polygraphy had most partial fails. Oximetry (Figure 1B) was the most likely cause of partial failures being worse in the Embletta and S-Med devices. Polygraphy devices had <2.5% data collection failure (Figure 1C) issues or short studies (Figure 1D) < 5% on all devices. As expected, attended PSG studies had least fails, and the most common failed signals were oximetry and airflow/respiratory traces.

Conclusions

1. Total failure rates in home polygraphy are usually under 5%.
2. Partial failure rates are around 40%, but this doesn't mean a repeat study is required.
3. The simpler the unattended system the lower the fail rate.
4. Data failure and short studies happen in only about 3%-5% of home sleep studies.

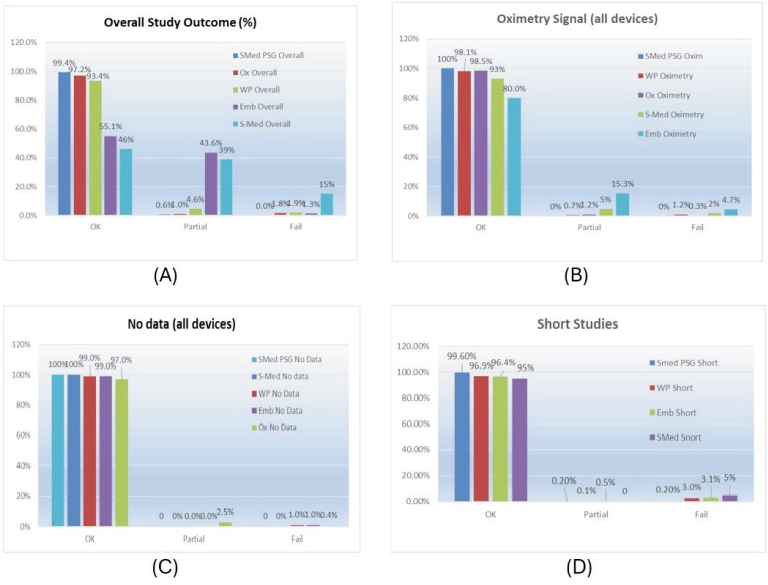


Figure 1.

RESEARCH AND AUDITS

A retrospective service evaluation to assess the need to perform an EBG prior to every initiation of CPAP therapy

Mrs Sheron Mathew[1], Mr. Frederick Jones[1], Ms. Claire Wood[2], Dr Kai Lee[2,3]

[1]Manchester metropolitan university, Manchester, United Kingdom, [2]King's college hospital NHS trust, London, United Kingdom, [3]King's college London, United Kingdom

Introduction

Earlobe blood gas [EBG] is routinely performed in all patients attending for a continuous positive airway pressure [CPAP] loan at the Trust. It was hypothesised that a significant decline in the overnight oximetry parameters was associated with an elevated daytime partial pressure of carbon dioxide [$PaCO_2$]; aiding in triaging patients that needed an EBG prior to CPAP initiation. This retrospective, non-blinded, one centre service evaluation aims to streamline the current sleep pathway, reducing direct costs and patient waiting times.

Methods

The study population included 213 patients (Male: 73%, Female: 27%) that attended their outpatient appointment between 19/07/2019 - 15/04/2021.

Results

8% of the study population showed a $PaCO_2$ ≥ 6.0kPa. Fisher's test showed there was no significant difference between body mass index [BMI] ≥30kg/m^2 (p= 0.4775), smoking history (p= 0.070), morning headaches (p= 0.093), timing of EBG (p = 0.802) and $PaCO_2$ in eucapnic and hypercapnic patients. Fisher's test showed that there was a significant difference between BMI of ≥35kg/m^2 (p = 0.019*) and $PaCO_2$ in eucapnic and hypercapnic patients. Spearman's correlation showed a weak positive correlation between BMI (r= 0.239, p= <0.001 *), oxygen desaturation index [ODI] (r= 0.252, p= <0.001*), Time spent with peripheral oxygen saturation [SpO_2] <90% (r= 0.258, p= <0.001 *) and $PaCO_2$ (kPa). Spearman's correlation showed a weak negative correlation between SpO_2 nadir (r= -0.284, p= <0.001 *), Mean spO_2 (r= -0.201, p = 0.003 *) and $PaCO_2$ (kPa). Cut-off values including time spent with <90% SpO_2 ≥ 11.7% (AUC = 0.845), SpO_2 nadir ≤ 74% (AUC = 0.801), Mean SpO_2 ≤ 92.7% (AUC = 0.780), BMI ≥ 34.8kg/m^2 (AUC = 0.712) were identified through receiver operating curve analysis that could aid in triaging patients that require an EBG.

Conclusions

Time spent with <90% SpO_2, SpO_2 nadir, Mean SpO_2 and BMI ≥35kg/m^2 should be used more routinely in clinical practice to triage the need for an EBG prior to a CPAP device loan. Further research is required to assess whether serum venous bicarbonate level, spot SpO_2 and neck circumference could be used to triage patients that require an EBG prior to CPAP initiation.

RESEARCH AND AUDITS

Evaluation of capillary blood gas testing pre-CPAP and routinely measured sleep study parameters as predictors of daytime hypercapnia

Ms. Rosie Geller-Stevens, Mr. Lewis Gidden

Introduction

Worcester Acute Hospitals Trust operates a physiologist-led sleep apnoea service with over 4000 patients. For individuals with suspected hypercapnia (pCO_2>6.0kPa), a capillary blood gas (CBG) test is required to confirm pCO_2 status, ensuring accurate diagnosis and treatment pathway. If patients exhibit SpO_2<90% for over 30% of total sleep time (SpO_2<90≥30%TST), they meet criteria for a CBG test to screen for daytime hypercapnia. Anecdotally, staff observed that some patients who met these criteria were not receiving CBG tests, and many patients with a pre-CPAP CBG did not have hypercapnia.

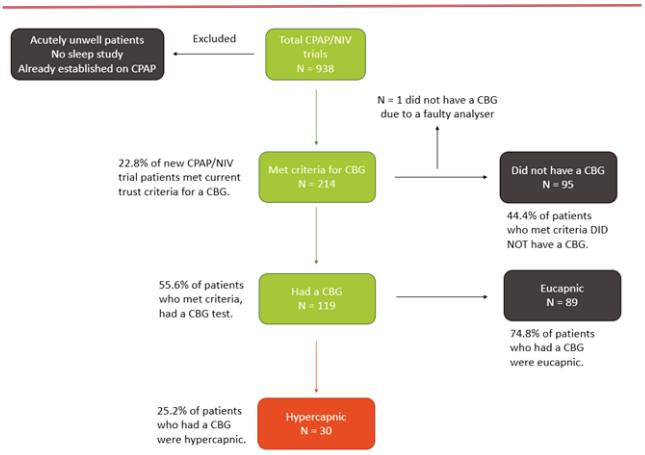
Aims

Evaluate sleep service compliance for CBG testing compared to local guidance, and whether local guidance is appropriate.

Evaluate whether other sleep study parameters may be better predictors of daytime hypercapnia, and can these be used to streamline the service.

Methods

Data was collected retrospectively from 938 patients who had a CPAP trial between September 2022-2023. Of these, 214 patients met the criteria for a CBG, and their outcomes were analysed. Compliance with local guidance was assessed, and CO_2 status of patients who received a CBG was determined. Various sleep parameters were also evaluated for their ability to differentiate between eucapnic and hypercapnic patients.



Pearson correlation coefficients, multivariate logistic regression, and receiver operating curves (ROC) were applied to assess model performance.

Results

44.4% of patients (n=95) who met criteria for a CBG, did not have a CBG pre-CPAP trial. Of those with a CBG (n=119), 25.2% (n=30) were hypercapnic. SpO_2<90 correlated with pCO_2 (r=0.310), while mean nocturnal SpO_2 showed a stronger correlation with pCO_2 (r=-0.407). Regarding discriminatory performance, SpO_2<90 had an AUC of 0.656. A model incorporating mean nocturnal SpO_2 and BMI demonstrated superior discriminatory power with an AUC of 0.758, which was significantly better than SpO_2<90 at distinguishing between hypercapnic and eucapnic patients (P=0.0253).

Conclusions

The sleep service is not meeting local guidance, with 44.4% of eligible patients not receiving a CBG pre-CPAP. A model incorporating mean nocturnal SpO_2 and BMI may provide improved discriminatory power for identifying patients who require a CBG, potentially improving service efficiency.

RESEARCH AND AUDITS

Is there a statistically significant difference between the auto-analysis report on WatchPAT in comparison to manual reporting?

Miss Ellen Carson, Mr. Francois Clavaud, Dr Vicky Cooper,
Salford Royal Hospital, Salford, United Kingdom

Introduction

WatchPAT® is a portable home sleep apnoea test and diagnostic device that uses innovative technologies to ensure the accurate detection of Obstructive Sleep Apnoea (OSA) (1). In this audit we compared the auto-analysis vs manual scoring for AHI3%, ODI3%, AHIc, AHI4%, ODI4% and Respiratory Disturbance Index (pRDI). We recorded the analysis time taken to manually score each study and compared the differences to determine if the manual scoring made a significant difference to the overall diagnosis of the study. We particularly wanted to check if manually scoring changed classification of severity of sleep apnoea on the study.

Methods

In this non-blind study, we compared the auto analysis reporting of watchpat vs manual reporting of 65 patients (Males=34) with an average BMI of 36.08kg/m^2 (Range: 19.8kg/m^2 – 54.4kg/m^2). The average age was 48 years (Range: 20yrs – 77yrs). The average time spent manually reporting the studies was 7 mins, 44 seconds (Range: 2mins, 22 seconds- 16 mins, 35 seconds). The values for AHI3%, AHIc, ODI3%, AHI4%, ODI4% and pRDI were recorded using the auto-analysis. The length of time to manually score the study was recorded using a timer and the difference in values recorded.

Results

Results are shown in Table 1. There was a significant difference noted across AHI3%, ODI3%, AHIc, AHI4% (P <0.001) and ODI4%, pRDI (P <0.05).

	Automatic Analysis (/hour)	Manual Analysis (/hour)	p-value
AHI3%	23.43 ±2.81	20.39 ±2.92	<0.001
ODI3%	23.25 ±2.80	20.64 ±2.89	<0.001
AHIc	2.18 ±0.55	0.31 ±0.17	<0.001
AHI4%	17.02 ±2.84	14.30 ±2.53	<0.001
ODI4%	15.19 ±2.61	14.74 ±2.70	<0.05
pRDI	26.93 ±2.87	23.86 ±2.77	<0.05

Table 1. Mean + St error of automatic vs manual analysis

Conclusions

When comparing Automatic and Manual scoring, there were significant difference noted across all parameters investigated. This shows that manual verification is still valid and appropriate when using WatchPAT device for OSA. This is supported by recent ARTP guidance that 'computer analyses should never be accepted without being validated by an experienced practitioner. If this validation has not been performed it should be clearly indicated on a report.' When exploring the clinical difference, there were several studies, which changed classification as noted in Table 2. Therefore, there could have clinical treatment ramifications with the changes in classification.

	Manual Analysis			
Automatic Analysis	No OSA	Mild OSA	Moderate OSA	Severe OSA
No OSA	7	0	0	0
Mild OSA	4	23	0	0
Moderate OSA	0	5	9	0
Severe OSA	0	0	9	9

Table 2. Matrix graph of the difference in AHI 3% classification of OSA comparing auto vs manual analysis

References
1. Accuracy of WatchPAT for the Diagnosis of Obstructive Sleep Apnea in Patients with Chronic Obstructive Pulmonary Disease - PMC
2. ARTP Standards of Care - Sleep Apnoea (Diagnostics) Version 8.docx

RESEARCH AND AUDITS

Long COVID and OSA. Is there an association between iron studies and sleep apnoea in long COVID patients?

Mr. Henry Hodgkins, Dr Joanna Shakepeare, Dr Timothy Robbins, Dr Kamaljit Chatha
University Hospital Coventry And Warwickshire, Coventry, United Kingdom

Introduction

Approximately 10% of individuals exposed to COVID-19 infection are estimated to be experiencing long-term sequalae (long-COVID), with common symptoms such as fatigue, brain fog and sleep disturbances remaining unresolved without an understanding of the underlying mechanisms. Obstructive sleep apnoea is an identified risk factor associated with increased severity of COVID-19 infection. Long-COVID patients are also at risk of iron dysregulation consistent with inflammatory disease (Hanson et al., Nat Immunol 2024; 25: 471-482). This study aims to identify a relationship between iron panels and underlying sleep apnoea.

Methods

A single-centre, retrospective, cross sectional design involved collating data from patients referred from the endocrinology Long-COVID clinic for; iron panel, full blood count, and home limited polysomnography between January 2023 and January 2024 (GafREC: GF0890; EthOS: 63233).

Abnormal iron panels were identified as one of the four variables (iron, ferritin, transferrin, or C-reactive protein) being outside normal limits. Sleep study results were classified as negative (apnoea hypopnoea index (AHI) <5 events/hour) or positive for sleep apnoea (AHI >5).

Relationships between variables were measured using Peason's correlation coefficient, and comparison between means by independent samples T-test's. Between groups effects were measured using one-way ANOVA.

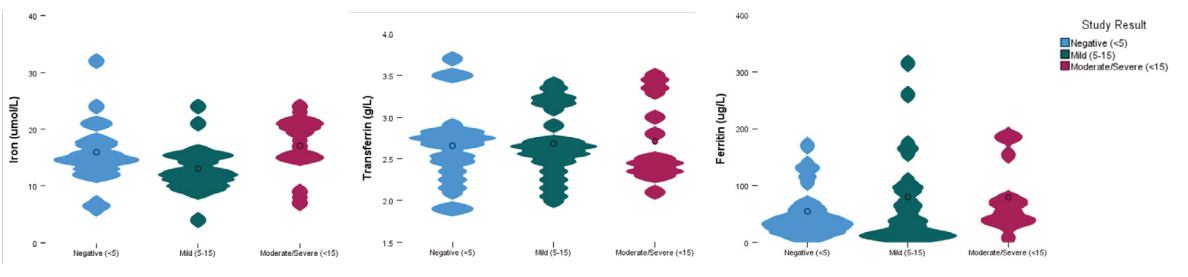
Results

Fifty patients were identified (64% female, n= 34; Age 47.7 ± 10.4 years; BMI 30.9 ± 7.6 kg/m^2) of which 32% (n = 16) presented with abnormal iron panels, and 62% (n = 31) with positive sleep studies. Sixty-seven percent (n= 37) reported a raised Epworth sleepiness score (ESS >10) with 22% (n = 11) classified as severe daytime somnolence (ESS >17).

Significant correlations between SpO_2 and ferritin (r2 -0.393, p = 0.005, 95% CI: -0.602 - -0.124), and TST90 and ferritin (r2 = 0.281, p = 0.048, 95% CI: 0 – 0.517) were found. There was no statistically significant effect of sleep study severity on iron, ferritin or transferrin (Figure 1).

Conclusions

Significant associations exist between ferritin and TST90 and SpO_2, however there are not significant differences between sub-groups, therefore not be possible to draw causative conclusions. The evidence of underlying sleep apnoea in this cohort merits further investigations such as the effectiveness of CPAP therapy.



RESEARCH AND AUDITS

Automatic analysis vs. manual scoring: comparing the two methods of scoring respiratory polygraphy sleep studies using the Visi-Download Stowood sleep software

Mrs Janina Mallari-Saguyan[1], Mr. James Pratt[1], Mrs Jessica O'Keeffe[1], Dr Adrian Kendrick[2]
[1]Great Western Hospital, Chippenham, United Kingdom, [2]University of West England, United Kingdom

Introduction

Manual scoring although time-consuming is the current gold standard when reporting sleep studies. Most sleep analysis software offers auto-analysis programmes and are often marketed as accurate and reliable.

Aims

The aim of this audit was the evaluate the agreement between automatic analysis and manual scoring in identifying patients with suspected Obstructive Sleep Apnoea (OSA) and its severity and the reliability of automatic analysis for accurate clinical outcomes.

Methods

A retrospective service audit was performed on sleep study data acquired between March 2024 to September 2024. 44 respiratory polygraphy studies were reviewed comparing automatic and manually scored Apnoea-Hypopnea Index (AHI). A regression analysis and Bland-Altman analysis was carried out to investigate the differences and correlation between the data and considering clinical outcomes into significance.

Results

19/44 results (43%) changed scoring severity classification, more so at AHI >5 events/hour and AHI >15 events/hour. Bland-Altman analysis shows that there is a wide variation with a mean difference of +2.578 and the 95% limits (-7.507 and +12.66) (Figure 1). 12/44 patients (27%) would potentially be in a different treatment category based on the automatic scoring analysis.

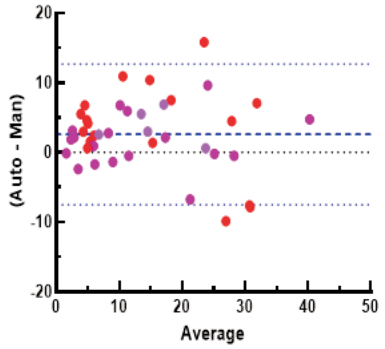


Figure 1. Bland-Altman plot of mean difference and the 95% limits. The red dots result in change in severity category and the purple dots remained in the same severity.

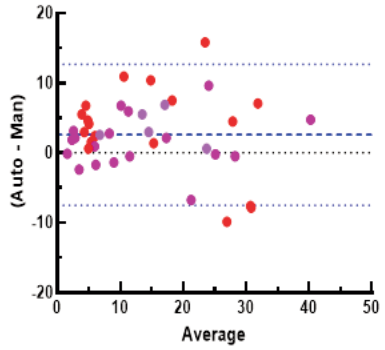


Figure 2. A linear regression analysis of automatic analysis (y-axis) vs. the gold standard manual scoring (x-axis). There are clear differences between the data as they do not all fit on the line of identity (orange dashed line).

Conclusions

The use of automatic analysis using our current sleep software Stowood (Visi-Download) for respiratory polygraphy studies is limited. It can provide a useful guide on predicting the severity of the AHI however is not reliable in providing accurate diagnosis for patients with suspected Obstructive Sleep Apnoea (OSA).

RESEARCH AND AUDITS

Underestimation of hypopnoeas by domiciliary screening may explain larger AHI on polysomnography

Dr James Stockley, Mr. Zishan Azzam, Prof Brendan Cooper
University Hospitals Birmingham, Birmingham, United Kingdom

Introduction

Some patients with a normal or borderline obstructive sleep apnoea (OSA) home sleep study have significant OSA when assessed by polysomnography (PSG). We hypothesized that this could be due to poor detection of hypopnoeas by domiciliary equipment and sought to determine if a high respiratory disturbance index (RDI) on the home study could predict this and prevent unnecessary PSG referrals.

Methods

All patients screened for OSA by home sleep study (WatchPAT, Itamar Medical, NL) and subsequent PSG were retrospectively reviewed over 12 months. Patients (n=90) had a WatchPAT (WP) apnoea/hypopnoea index (AHI) <10 and no significant central sleep apnoea. Relationships between AHI, RDI and hypopnoea index (HI) were assessed by Spearman Rank and agreement was assessed by Bland-Altman plot. Differences in confounding factors (BMI, %REM sleep, %supine sleep) were assessed using a Wilcoxon Signed Rank test. CPAP prescription after PSG and long-term compliance were assessed as secondary outcomes.

Results

Patients were 43M:47F, mean age 45 (range 22-77), median AHI-PSG 13.6 (IQR 5.4-25.8). There was a preponderance of hypopnoea-dominant OSA, with a median %HI-PSG (of total AHI) of 91.6 (IQR 78.1-98.1). There was no relationship or agreement between AHI-WP vs AHI-PSG, HI-WP vs AHI-PSG, or RDI-WP vs AHI-PSG. However, the difference in AHI between the two studies correlated significantly with HI-PSG (r2=0.643, p<0.0001) with strong agreement overall (Figure 1). Patients spent more time supine during their home study 53.5% (IQR 34.8-70.7) vs PSG 33.9% (IQR 13.3-53.2) (p<0.0001) and in REM sleep 23.3% (IQR 17.3-27.5) vs 12.5% (IQR 7.8-15.3) (p<0.0001) but there was no difference in BMI between studies. CPAP was requested in 54% of patients after PSG, but successful long-term compliance was only achieved in 45% of these.

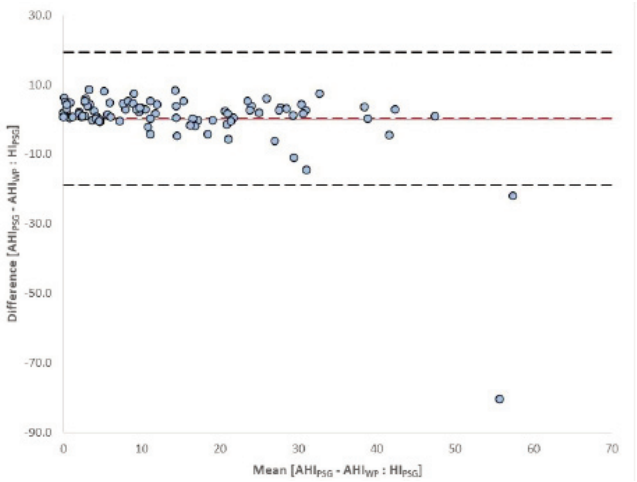


Figure 1. Bland-Altman plot comparing the difference in AHI between the home WatchPAT study and PSG (AHI_{PSG}-AHI_{WP}) versus the HI by PSG (HI_{PSG}). The mean difference (red dotted line) was 0.217 with most data clustered closely around this, suggesting good agreement and inferring that the difference in AHI between the two studies in most cases could be explained by a lower detection rate of hypopnoeas by the WatchPAT device. There was one clear outlier, but no explanation was found for this.

Conclusions

The difference in AHI between home test and PSG seems to relate to an underestimation of hypopnoeas by WatchPAT rather than differences in known confounders of OSA. It is not possible to obviate the need for PSG in some patients based on RDI-WP as this did not reflect a HI. Hypopnoea-dominant OSA patients may be less likely to adhere to treatment long-term but requires exploration in a future comparative study.

RESEARCH AND AUDITS

Service evaluation of CPAP monitoring to assess quality of care for obstructive sleep apnoea patients without CPAP modems

Miss Nina Caulton[1], Mr. Gavin Comber[1], Professor Sonia Correa-Muller[2]

[1]University Hospitals of North Midlands, Stoke-on-Trent, United Kingdom, [2]Manchester Metropolitan University, Manchester, United Kingdom

Introduction

Continuous positive airway pressure (CPAP) therapy is the gold standard treatment for obstructive sleep apnoea. To ensure patients are treated effectively, CPAP users are monitored and regarded as compliant when using the device ≥70% of days ≥4 hours/day. Modem devices can be installed to transmit CPAP clinical data to hospitals to facilitate remote monitoring. During the COVID-19 outbreak, University Hospitals of North Midlands (UHNM) changed clinical reviews from face-to-face to telephone, resulting in long-term patients without modems having to report their usage with limited data. We wanted to evaluate whether CPAP users without modems between May 2020 and May 2022 would have been given different clinical outcomes or follow-up plans if they had a modem installed.

Methods

Data was collected retrospectively from UHNM's EncoreAnywhere database. 154 patients were recruited who completed a telephone review between May 2020 and May 2022, did not own a modem during this period, and were provided with a modem after June 2022 as part of UHNM's CPAP Swap Scheme. Descriptive methods, intraclass correlation coefficient (ICC) and Kendall's tau-b were used to measure the reliability of patient-reported data compared to modem-integrated data.

Results

70% of patients used their CPAP ≥70% of days ≥4 hours. There was not a significant agreement between patient-reported 30-day and modem-integrated 180-day usage (≥70% compliance, ≥4 hrs daily usage. N=73, ICC = 25%; p = 0.11). Modem-integrated data revealed 179 CPAP therapy issues in 50% of patients that were undetectable from the patient-reported data at the time. Modem-integrated data revealed 45.5% of patients would have needed changes to their treatment. 24% of patients needed a 3-month follow-up instead of a 12- or 24-month follow-up.

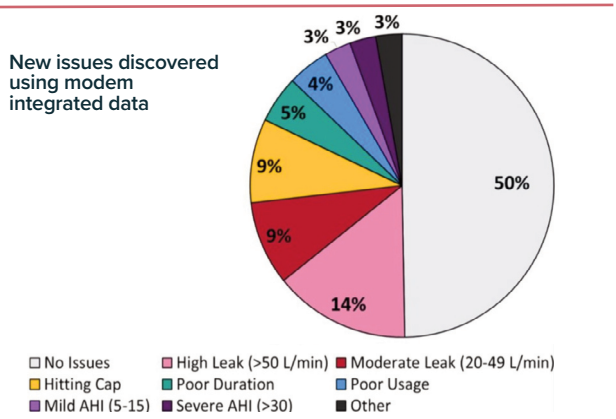


Figure 1. Percentages of CPAP issues that were not detected by clinicians or patients from the subjective data obtained during telephone reviews. Number of responses = 179

Clockwise: No issues (89); High leak (26); Moderate leak (16); Hitting cap (16); Poor duration (9); Poor usage (8); Mild AHI (5); Severe AHI (5); Other (5)

Conclusions

The objective data from modems can reveal significant therapy problems that were not detected from patient-reported data alone. For this reason, our results support the use of modems for long-term patients. However, the feasibility of effectively resolving all therapy issues with the sleep department's limitations during the COVID-19 outbreak had they been discovered at the time is debatable.

RESEARCH AND AUDITS

Audit of signal failure rate of commercially available home sleep diagnostics

Prof Brendan Cooper, Alison Butler, Mr. Richard Glover, Mrs Jodie Hunt, Mrs Theresa Cunnington, Dr James Stockley, Dr Julie Lloyd

University Hospitals Birmingham, Birmingham, United Kingdom

Introduction

We reviewed the technical failure rates of 3 commercially available home sleep diagnostic kits to see what the key signal failure rates were. Signals were categorised into (OK) no failures, (Partial) partial failures (>1 hour but didn't affect the clinical outcome overall and (Fail) fully failed which affected the study.

Methods

We audited 1156 routine home sleep studies across 4 sites to determine the failure rates of (i) Embletta (n=385 over 14 months), (ii) Smed (n=100 over 1.5 months) (iii) WatchPAT (n=671 over 17 months) devices. Channels included (if available*) oximetry, respiratory, snoring, thorax*, abdomen*, PAT* and body position using fail rates per total device studies.

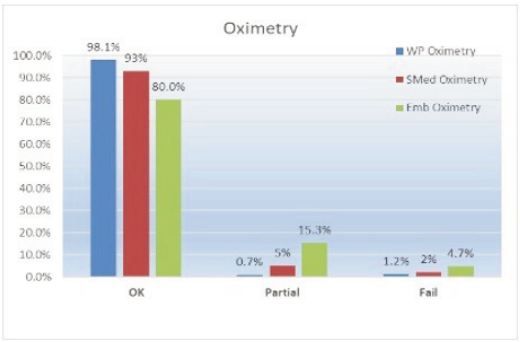
Results

The signal fail rates Figure 1 (A-E). show Embletta oximetry signal was worst (15.7% partial and 4.7% full failure) (Figure 1A) & the respiratory signal is the most likely to fail (Figure 1B) especially in the Embletta and S-Med devices. All polygraphy devices failed less than 1% for Snoring (Figure 1C) or position (Figure 1D) signals. Abdomen/thorax signals (Figure 1E) showed partial failure especially with the Embletta abdominal signal.

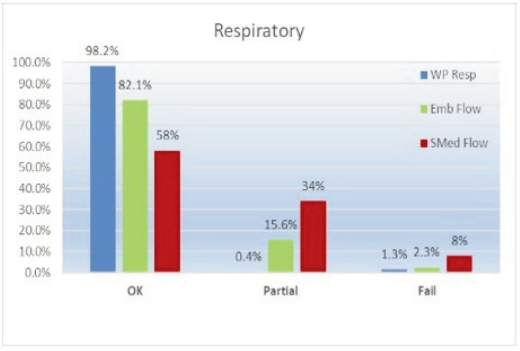
Conclusions

As expected, the most failed signals were oximetry and flow/respiratory traces. The WatchPAT flow failed least the WatchPAT finger probe rarely became dislodged. The Embletta oximetry and abdominal signals were the least reliable of all devices. However, the Embletta abdominal signal is often set up by the patient. The explanation for this is unclear and requires further investigation.

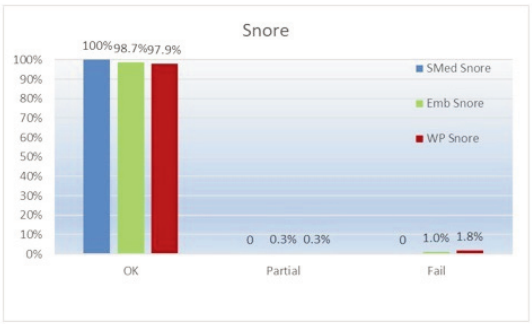
1. Respiratory signals have the highest partial failure rates (15-30%) in the 3 systems, mainly due to abdominal/thorax probe failures.
2. Full respiratory failure rates are around 1-8%.
3. The Embletta had the worst oximeter fail rate (15.3%) but the WatchPAT failed least (0.7%).
4. Snoring and position signals have virtually no failure rates on all devices.



(A)

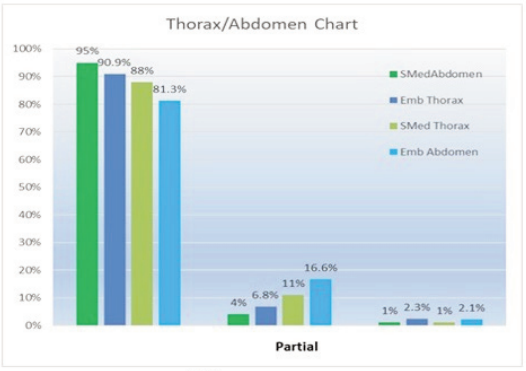


(B)



(C)

(D)



(E)

Figure 1.

RESEARCH AND AUDITS

A comparison of nocturnal pulse oximetry indices measured via Masimo, Nonin, and Radiometer devices

Mr. Ricky Damm, Mr. Matthew Davies, Mrs Mollie Riley
Great Ormond Street Hospital for Children, Great Ormond Street, United Kingdom

Accuracy of nocturnal pulse oximetry (NPO) is paramount to the diagnosis of paediatric sleep disordered breathing (SDB). Oxygen saturation (SpO_2) measurements can vary depending on the device and sensor type. Masimo device SpO_2 values are within +/-2% of arterial blood gas measurements (McDermott, 2023) and demonstrate improved accuracy in cases of severe hypoxia or motion artifacts compared to Nonin (Elron et al., 2023). Radiometer devices, such as the TCM5 utilise reflectance sensors and rarely outperform Masimo or Nonin in terms of accuracy, such as during sleep or in the presence of motion (Emdin et al., 2015). We aimed to compare SpO_2 measures (mean, ≥3% desaturation index (ODI), Nadir) from the three NPO devices in our heterogenous paediatric population.

We recorded NPO in children (4 months - 18 years) referred to Great Ormond Street Hospital for a diagnostic cardiorespiratory sleep study between 10/2020 – 09/2021, using three devices simultaneously. Masimo Rad-97® with Masimo single-use wrap sensor (applied to toe), Nonin PureLight® reusable FlexSensor as part of the Natus® Embla® NDx system (applied to toe), and Radiometer Ltd TCM5 with Sensor 92 reflectance sensor (applied to forehead) were used. Stowood Ltd Visi-Download software was used to analyse Masimo and Radiometer data. Natus® Embla® Remlogic was used for Nonin. An estimated total sleep time with ≥6 hours of recording with good signal quality was required.

Simultaneous NPO was achieved in 57 children. Mean±SD age was 7.4±4.5 years, 33 (58%) were male, and 33 (58%) had comorbidity. Friedman test revealed a significant difference between the three devices for mean SpO_2 ($X2 = 16.7$, $p<0.05$), ODI ($X2 = 17.4$, $p<0.05$) and SpO_2nadir ($X2 = 28$, $p<0.05$). Masimo ODI was lower than Nonin ODI (median (IQR) 2.4(4.1) vs 3.6(2.1), $p<0.05$) and Radiometer ODI (2.4 (4.1) vs 5.9 (13.25), $p<0.05$). Masimo nadir SpO_2 was higher than Nonin nadir SpO_2 (91(7.25) vs 89(7.0), $p<0.05$) and Radiometer nadir SpO_2 (91(7.25) vs 84.5(13.5). No difference was seen with Nonin and Radiometer for ODI or nadir SpO_2.

NPO SpO_2 measurements vary between the three devices in our heterogenous paediatric population. Further research is required to determine whether using different devices leads to different diagnostic outcomes.

	Masimo	Nonin	Radiometer
Mean SpO_2	97.8 (1.65)	96.6 (1.4)	97.4 (2.1)
ODI	2.4 (4.1)	3.6 (2.1)	5.9 (13.25)
Nadir SpO_2	91 (7.25)	89 (7.0)	84.5 (13.5

Results presented as median (IQR)

RESEARCH AND AUDITS

Home oximetry screening for sleep disordered breathing in children with Down Syndrome

Miss Laurie Mccartney, Mr. Philip Lawrence, Dr Ruth Trinick, Dr Gemma Saint
Alder Hey Children's Hospital, Liverpool, United Kingdom

Introduction

Children with Down syndrome (DS) are at risk of obstructive sleep apnoea (OSA) which can cause complex problems (Hill et al., Sleep Medicine 2016; 27-28: 99-106). Whilst polysomnography (PSG) is recommended to diagnose OSA (Simpson et al., Nature and Science of Sleep 2018; 10: 287-293), home oximetry monitoring can be effective to determine those in urgent need of further testing (Hill et al., Archives of Disease in Childhood 2018; 103: 962 -967). We recently started a routine screening program for this patient group.

Methods

We screened 64 patients (0.5 – 5 years) with DS using home oximetry monitoring (Masimo Rad 97 Pulse Oximeter, CA, USA) for 2 nights at home annually until the age of 5. The results were downloaded using Visi-download (Oxford, UK) and mean saturations, oxygen desaturation index (ODI), nadir and Delta 12s index were analysed. The reports were then reviewed by a respiratory consultant who determined the next steps.

Results

164 studies were performed on 64 individual patients. There was adequate data in 93.8% studies. 36 patients (56.3%) had normal results. 28 patients (43.8%) were found to have abnormal results. 11 (17.2%)of these were referred for PSGs and 14 (21.9%) were referred to a specialist joint Respiratory/ ENT clinic for possible tonsillectomy and/or adenoidectomy. 1 (1.6%) patient required immediate admission and set-up on CPAP. Table 1 shows the data from both patients with normal and abnormal results.

	Normal (n = 36)	Abnormal (n = 28)
Mean O_2 Saturations (%)	94.59 (1.76)	93.62 (2.67)
O_2 Desaturation Index	7.38 (7.17)	12.72 (10.32)
O_2 Nadir (%)	82.25 (5.58)	79.98 (8.65)
Delta 12s Index	0.60 (0.22)	0.79 (0.34)

Table 1. The mean (SD) data from the normal and abnormal groups

Conclusions

This audit highlights the importance of screening individuals with DS. Our findings show that 43% of patients required further evaluation, despite no specific clinical concern. These results highlight the need for routine screening to enable early intervention to improve patient outcomes and quality of life. Early detection can play a key role in managing health risks associated with DS. Home oximetry is both simple and quick, with shorter wait times than PSG. Although 17% required further PSG testing, this study supports the use of initial screening via home oximetry to prioritise those in urgent need and safely monitor those with lesser symptoms.

RESEARCH AND AUDITS

Which monitor is better? Transcutaneous carbon dioxide monitoring in children

Mr. Steven Campbell, Mr. Matthew Rose, Mr. Theophilus Polychronakis
Cambridge University Hospitals NHS Foundation Trust, Cambridge, United Kingdom

Introduction

Transcutaneous Carbon Dioxide monitors ($tcpCO_2$) are used to assess nocturnal gas exchange efficiency in children with various sleep breathing disorders. The American Academy of Sleep Medicine (AASM) 2023 manual defines nocturnal hypoventilation in children when > 25% of the total sleep time is spent with pCO_2 > 50mmHg (6.7kPa). Studies have shown discrepancies between $tcCO_2$ and arterial pCO_2, as well as technical challenges obtaining $tcCO_2$ data overnight. We compared the performance of two different $tcCO_2$ monitors in children in terms of quantity and quality of data collected and if the position of the sensor probe had any impact.

Methods

This was a prospective analysis of 57 children undergoing consecutive hospital-based cardio-respiratory polygraphy over a two-month period in our nurse led sleep lab. Patients attending hospital for cardiorespiratory sleep studies on PAP therapy were excluded from the audit.

Results

29 patients underwent studies on TCM5 (Radiometer, UK) and 28 patients on Sentec TCM (Sentec, UK) over a period of two months. Data was analysed using Visi-Download (Stowood Scientific Instruments). Statistical significance between the data acquired across both monitors was calculated using paired t-tests. Mean age, sex, height, weight and AHI were not statistically different between both groups. CO2 mean was significantly different between Sentec and TCM5 (5.15kPa vs 6.02kPa), as was CO2 max (5.75kPa vs 7.06kPa). Four patients met hypoventilation criteria using TCM5 and only one using Sentec. Mean tcCO2 was higher in patients using TCM5, however time > 6.7kPa was not significantly different between groups. There were 27 studies in the TCM5 group vs 19 studies in the Sentec group with recording > 6hrs, however % artefact removed between both groups was not significant. Artefact was irrespective of site location on TCM5, however using Sentec was more common with the forehead.

Data	Sentec	TCM5
Patient Demographics		
Age (years)	M = 7.02 SD = 4.17	M = 6.85 SD = 44.45
Height (cm)	M = 115.62 SD = 32.71	M = 117.45 SD = 44.45
Weight (kg)	M = 35.86 SD = 29.89	M = 47.42 SD = 44.5
Numbers of Patients:	28	29
Obesity	*3*	*6*
NMD	*2*	*3*
ENT/CLEFT	*12*	*3*
Genetic	*5*	*8*
Respiratory/ Sleep concern	6	9
TcpCO2 Data		
Number of Studies > 4hrs	26	29
Number of Studies > 6hrs	19	27
% artefact	M = 22.46 SD = 0.2	M = 28.34 **NS** SD = 0.18
CO2 min (kPa)	M = 4.54 SD = 1.08	M = 4.89 **NS** SD = 0.65
CO2 mean (kPa)	M = 5.15 SD = 1.2	M = 6.02 * SD = 0.76
CO2 max (kPa)	M = 5.75 SD = 2.01	M = 7.06 * SD = 1.33
CO2 time > 6.7kPa (%)	M = 3.43 SD = 14.02	M = 14.98 **NS** SD = 27.6
AHI CR Polygraphy	M = 2.92 SD = 3.62	M = 4.1 **NS** SD = 5.19

Table 1. Summary demographic data and comparison of the quality/quantity of $tcCO_2$ data acquired from groups. Data expressed as mean (M) and standard deviation (SD). NS = non-significant P value; *significant P value <0.05; **significant P value <0.001

Conclusions

There appeared to be no significant difference in % artefact excluded from analysis time between either monitor. TCM5 group showed more studies recorded > 6hrs and artefact was regardless of sensor probe position. Forehead site was used in younger patients and Sentec appeared to perform less well compared to other probe sites in terms of artefact.

RESEARCH AND AUDITS

Validation of WatchPAT for pre-operative screening of OSA in bariatric surgery patients

Dr Gillian L Twigg, Dr Lola Loewenthal, Ms. Hannah Tighe, Ms. Ana Lopes, Dr Brendan Mallia-Milanes

Imperial College Healthcare NHS Trust, London, United Kingdom

Introduction

Many services are using wearable technologies with automated scoring algorithms to meet growing demand for OSA screening, including bariatric surgery candidates, who have a fundamentally different physiology. WatchPAT has been validated against polysomnography but studies have not specifically focussed on bariatric patients. This study aimed to compare AHI from WatchPAT 300 to respiratory polygraphy (RP, Embletta MPR) in patients undergoing bariatric surgery and sleep clinic controls.

Methods

Patients referred on the bariatric pathway for pre-operative screening of OSA were eligible to take part. A comparator group comprised of GP referrals with suspected OSA (BMI < 35kg/m^2). Exclusion criteria were use of medications or conditions known to affect the PAT signal (long-acting nitrates, alpha blockers, sympathectomy). Patients wore RP and WatchPAT concurrently for one night. RP signals were manually scored to produce an apnoea hypopnoea index (AHI) with start and stop times aligned to the time of sleep onset and final awakening determined by WatchPAT. WatchPAT AHI was automatically generated. Primary outcome measure was difference in AHI (WatchPAT-RP) and was compared statistically with Mann-Whitney U.

Results

85 patients (53 bariatric) were included in the final dataset. Bariatric patients had a higher BMI than sleep clinic referrals (mean ± SD 46.52 ± 9.06 versus 28.62 ± 4.02 kg/m^2, p=0.000) and had a greater percentage of females (77 versus 34%). The groups were similar in age (43.23 ± 11.61 versus 45.53 ± 11.98 years, p=0.391). Median (range) AHI was higher in WatchPAT compared to RP in both groups [bariatric: 21.8 (3.9-103.8) versus 9.60 (0-115.7) events/ hour, p=0.000; controls 26.7 (2.3-81.5) versus 9.25 (0.3-73.3) events/ hour, p=0.000]. Classification of severity revealed 43% of the bariatric group and 57% of all patients classed as having a normal or mild AHI on RP were classed as moderate or severe on WatchPAT.

Conclusions

Demand for pre-operative screening for OSA constitutes a significant part of the workload for sleep clinics. CPAP is often prescribed peri-operatively for bariatric surgery patients with at least moderate OSA. Further research is needed to understand the reasons for the differences in AHI between RP and WatchPAT and to determine the clinical significance.

RESEARCH AND AUDITS

An evaluation of the service approach to CPAP follow up consultations pre and post COVID-19

F Jones[2], **Miss Liza Kovacs**[1], Dr Gillian Twigg[1]

[1]Imperial College Healthcare NHS Trust, Sutton, United Kingdom, [2]Manchester Metropolitan University, Manchester, UK,

Introduction

Prior to the COVID-19 pandemic, the Sleep Centre Service at Charing Cross Hospital only delivered care via face-to-face appointments. Once the Sleep Centre was permitted to re-open in August 2020 following the redeployment period, we began our 'recovery' phase. We adopted a 'no contact' service wherein we began using different forms of telecommunication. After the recovery phase, these changes remained in place. In this retrospective clinical audit, we aim to examine whether there is a statistical difference in CPAP compliance within our 2019 (pre-COVID) and 2022 (post-COVID) cohorts. We also aim to identify common reasons for non-compliance and recommend ways to improve the service.

Methods

A total of 213 newly diagnosed patients who commenced their treatment in 2019 and 2022 respectively were vetted against the inclusion and exclusion criteria. Compliance reports from the first 2 initial follow ups, accessed via clinical notes was analysed via utilising the Mann-Whitney U test to determine whether there are statistically significant differences in CPAP compliance between the two cohorts. The primary inclusion criteria was to include "CPAP naïve" patients; patients with no prior knowledge and experience to CPAP. This means patients who have previously been established on CPAP or used alternative treatment forms were not included. Patients referred as part of the Bariatric Pathway were also excluded. Common reasons for non-compliance were separated into specific categories and analysed via thematic analysis.

Results and Conclusions

There was a statistical difference in CPAP compliance (*P=0.0332) found during the second follow up in the 2022 cohort. There was also a 25% increase in patients contacting the sleep centre for troubleshooting between appointments. Within the 2019 cohort, the most common reason for non-compliance was related to mask fit issues however it in 2022 the leading concern became adherence. Overall, the data shows that the adaptations made to our service delivery have not impacted CPAP compliance negatively. Service improvement recommendations such as the need to consider alternative pathways for non-tolerant patients and the need to review standard operating procedure for mask fitting will be made to the clinical team.

RESEARCH AND AUDITS

The Glenfield Epworth Modified Score (GEMS)

Mr. Stephen Wimpress, **Mr. Muhammad Patel**
University Hospitals Leicester, Leicester, United Kingdom

Introduction

The Epworth Sleepiness Score (ESS) is a renowned and patented international patient symptom questionnaire. It is used to help diagnose Obstructive Sleep Apnoea Syndrome (OSAS). It consists of eight questions which the patient must answer on a scale of 0 (never) to 3 (highly likely) on the likelihood of dozing or falling asleep in different situations.

From many years of experience in sleep disorders, and particularly the diagnosis of Obstructive Sleep Apnoea Syndrome (OSAS) the department found two questions on the ESS which more than often scored low by our patients.

These were

1. Sitting inactive in a public place e.g. theatre. meeting and others.
2. In a car while stopped in traffic.

The aim of this study was to substitute these questions with two that we felt were more appropriate in assessing for sleepiness and helping to identify patients with possible Obstructive Sleep Apnoea Syndrome.

Methods

A modified ESS we called the Glenfield Epworth Modified Score (GEMS) was created with two substitute questions.

These questions were

1. The likelihood of have recurrent awakenings during your sleep
2. The likelihood of feeling unrefreshed after your sleep.

A clinical audit was then carried out using questionnaires of the ESS and GEMS issued to all patients who were investigated for OSAS with home sleep study equipment (The Resmed Noximeter). These were completed and returned with their sleep equipment after one night's sleep study in their homes.

Results

145 patients who completed the ESS and GEMS showed significantly higher scores with the GEMS questionnaire.

The combined score of the two questions from the ESS was 149 compared to 557 from the two Gems substitute questions.

The mean results of all 145 patients showed 7.97 from the ESS and 12 from the GEMS. (>10 is deemed significant with the ESS).

Conclusions

The results and conclusion of this study is that we heavily endorse the use of GEMS as a substitute for the ESS to assess patient symptoms and thus in the diagnosis of OSAS with partial polysomnography sleep studies.

RESEARCH AND AUDITS

Clinical scientist led clinics for severe sleep apnoea patients: a solution to a growing problem

Mr. Richard Madeley

Leeds Teaching Hospitals, Leeds, United Kingdom

Introduction

Obstructive sleep apnoea is an increasingly common, life altering condition with an efficacious treatment option in the form of continuous positive airway pressure (CPAP). Unfortunately, after diagnosis there can be issues and delays establishing patients on therapy. Meanwhile there are significant risks for associated comorbidities to cause harm or hospitalisation whilst these patients await treatment.

At Leeds Teaching Hospitals, with the historic pathways, patients can wait up to 8 months after having a confirmed diagnosis of sleep apnoea to having a clinic appointment with a medical consultant. This is clearly an unsatisfactory length of time to wait for explanation of the results, with further waiting list time for establishing on treatment after the medical appointment. To improve this, a system has been implemented within our service. Whereby, a triage process identifies higher risk patients and they are established on a one-stop pathway, allowing for an appointment with a Clinical Scientist the day after their sleep study and establishment on CPAP, if appropriate.

Aim

To assess the efficacy of Clinical Scientist led 'one stop pathway' in improving patient experience and time to treatment.

Methods

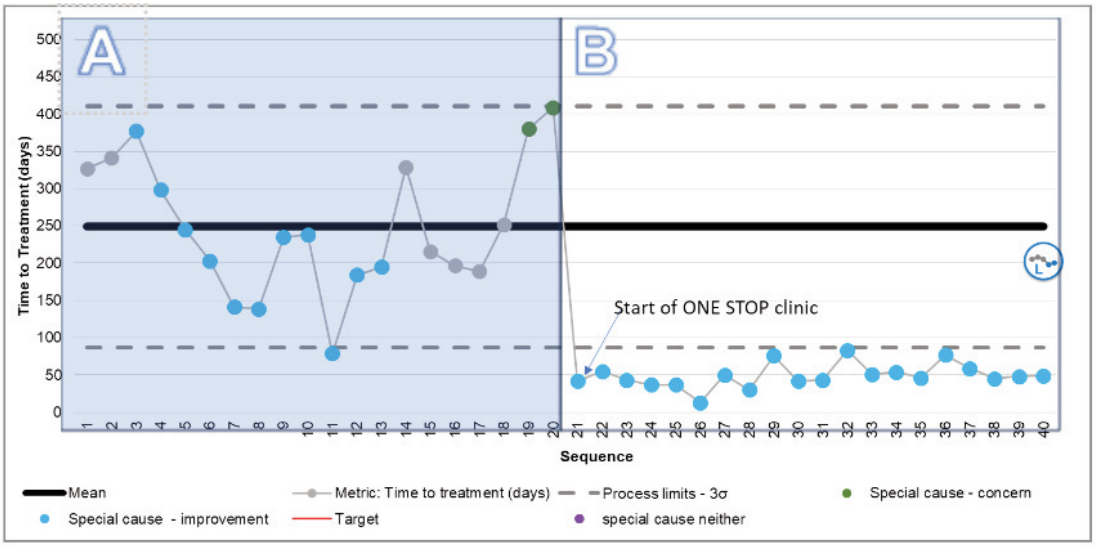
Data from patients from the historic system and patients from the one-stop system were compared for key waiting list milestones. Including time to sleep study, time to clinic appointment and time to establishing treatment.

Results

The median time to sleep study was comparable, at 45 days and 46 days respectively. Whereas, the time to clinic appointment was significantly shorter for the patients on the one-stop pathway, reducing the median time waiting from 118.5 days for a clinic appointment to 47. Additionally, the median total time to establishment on treatment was reduced from 236.5 to 47 days. Raw data in XmR chart is presented in Figure 1.

Conclusions

Increasing availability of appropriately trained staff to deliver expedited CPAP for severe OSA patients has significant reduction in time to treatment, which is not explained by expedited diagnostic tests.



A) Historic patient pathway time to treatment, one point of improvement identified by the XmR process. However, non-sustained and rose within the period shown. Breakdown of the total time is presented within table 1.
B) 20 patients presented after the initiation of the one-stop service, a significant reduction in time to treatment is evident.

Figure 1. XmR Chart for time to treatment initiation with CPAP

RESEARCH AND AUDITS

An audit of WatchPAT home sleep study PAT signal failures

Prof Brendan Cooper, Mrs Jodie Hunt, Mrs Theresa Cunnington, Dr James Stockley
University Hospitals Birmingham, Birmingham, United Kingdom

Introduction

We explored the failure rate of WatchPAT home sleep studies which uses peripheral arterial tone (PAT). PAT contraindications include medications (alpha blockers, phosphodiesterase inhibitors and long-acting nitrates), and some medical conditions (peripheral neuropathy, vasculopathy, cardiac conditions and hypertension. However, there may be other reasons including short studies, data failures or other failures.

Methods

We reviewed 4287 consecutive WatchPAT (Itamar, Netherlands) studies and categorised them into (OK) no failures, (Partial) partial failures (where >1 channels failed for >1hour but clinical outcome unaffected and (Fail) fully failed where was outcome affected. Subject characteristics were M: F = 71:68, Median age = 45.0 (17.3) years, Overweight (14.4%), Obese (72.6%).

Results

297 (6.9%) had either partial (3.9%) or full (3.0%) failed studies. 59.4% of the failed studies required a repeat study (4.1% of studies). (3.2%) of the failed studies were caused by PAT signal failure with full failure (72.7%) or partial failure (27.3%). Relevant patient clinical details (age, BMI, BP and sex) with

A

TABLE 1	Oximetry	Resp	Snore	PAT	Position	Short	No Data	Overall
Normal	72.4%	78.2%	80.9%	51.2%	86.7%	51.9%	81.6%	6.8%
Partial	9.9%	3.4%	2.4%	13.0%	2.0%	5.1%	2.4%	49.5%
Fail	17.7%	18.4%	16.7%	34.5%	11.3%	43.0%	16.0%	43.7%

B

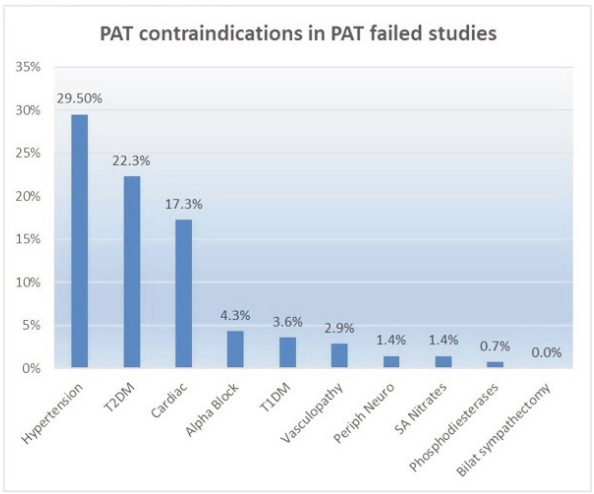


Figure 1. A: WatchPAT fail rates by channel (n=293) and B: Contraindications

conditions or medications were taken from the electronic record to identify PAT contraindications.

25% of full fails had total data failure too, and 17% were total fails and short studies. Study outcomes showed that most clinical outcomes were for moderate (6.8%) or severe (15/7%) OSA. The rate of patients with PAT contraindications (Figure 1) shows that the main contraindications were hypertension (29.5%), Type 2 diabetes (22.3%) and cardiac conditions (17.3%). <5% contraindicated medications were taken by patients in failed studies.

Conclusions

1. Failed PAT studies account for only 6.9% of studies with PAT signal failure causing 3.2% of failures.
2. Failed PAT studies resulted from short studies (43%), failed PAT signal (35%) or failed data collection, or several factors contributing.
3. Usual contraindicated medications and clinical contraindications accounted for few failed studies.
4. Most PAT study failures happened in patients with a history of hypertension, Type 2 diabetes or cardiac conditions.